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Experiments With Cotton Varieties in Louisiana
1947-1950

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By

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EXPERIMENTS WITH COTTON VARIETIES IN LOUISIANA, 1947-1950

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Part I

Cotton Variety Tests, 1947-1950

INTRODUCTION

The estimated* acre yield of lint in Louisiana fluctuates with weather conditions and the prevalence of insects, but the state average acre yield of lint in Louisiana has gradually increased for the past eighty years. The highest estimated acre yield of lint—392 pounds—was attained in 1948. Louisiana cotton farmers receive more money from cotton and cotton products than from any other crop in the state. It behooves each grower to choose his variety of cotton carefully and protect it from damaging insects during the growing season.

New varieties and strains are being developed continuously, and this summary of cotton variety experiments was prepared so that one can evaluate the long-time results from certain varieties. The preliminary mimeograph reports of the Crops and Soils Department from 1947 through 1950 give the detailed report on cotton variety and strain tests.

This report presents the average results from a number of varieties that have been tested at five experiment stations located in Louisiana. The data at the separate stations were combined and analyzed statistically so that variety behavior may be evaluated.

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* Montgomery, J. P., "Louisiana Cotton Statistics with Comparisons," Louisiana Experiment Station, Bulletin No. 439, 1949.

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PROCEDURE

The yield of seed cotton is based upon the mean weight from six single-row plots at each location. Each plot was approximately 100 feet in length. Lint per cent is determined by ginning two 100-boll samples from each variety on a small roller gin.

The boll size, lint per cent, and staple length determinations were secured from these 100-boll samples. The fiber length determinations were made by Harvey B. Martin and his associates of the Production and Marketing Administration Cotton Classing Office at Alexandria, La.

The planting, cultivation, and harvesting of the cotton variety tests located throughout the state were conducted by C. B. Haddon, J. Y. Oakes, D. M. Johns, and R. S. Woodward at the respective stations. The Baton Rouge tests were conducted by F. W. Self, Jack E. Jones and John R. Cotton.

The seed used in these cotton variety tests were obtained from the following sources:

Acala 4-42—Grown in cooperation with the U. S. D. A. for spinning trials.
Acala 1517W—Grown in cooperation with the U. S. D. A. for spinning trials.
Bobshaw—Bobshaw Seed Company, Indianola, Miss.
Cobal T-416—U. S. Cotton Field Station, Knoxville, Tenn.
Coker 100 WR—Coker's Pedigreed Seed Co., Hartsville, S. C.
Coker 100 Staple—Coker's Pedigreed Seed Co., Hartsville, S. C.
CRI—Oklahoma Cotton Research Station, Chickasha, Okla.
Delta Smooth Leaf—Delta Branch Experiment Station, Stoneville, Miss.
Deltapine 14—Delta and Pine Land Co., Scott, Miss.
Deltapine 15—Delta and Pine Land Co., Scott, Miss.
Delfos 444—Northeast Louisiana Experiment Station, St. Joseph, La.
Delfos 651—Delta Branch Experiment Station, Stoneville, Miss.
Delfos 9169—Stoneville Pedigreed Seed Company, Stoneville, Miss.
Empire—Empire Pedigreed Seed Company, P. O. Box 7, Haralson, Ga.
Fox—Delta and Pine Land Company, Scott, Miss.
Louisiana 33—Louisiana Agricultural Experiment Station, Baton Rouge, La.
Louisiana 47—Louisiana Agricultural Experiment Station, Baton Rouge, La.
Louisiana 310—Louisiana Agricultural Experiment Station, Baton Rouge, La.
Mebane 6801—Oklahoma Cotton Research Station, Chickasha, Okla.
Miller 610—Mississippi State College, State College, Miss.
Miller 919—North Louisiana Experiment Station, Calhoun, La.
Marett's E-1-21-2-3-10—Marett's Farm and Seed Co., Westminister, S. C.
Paula—Deering Farm Incorporated, Deering, Mo.
Plains—Alabama Agricultural Experiment Station, Auburn, Ala.
Sealand 542—W. H. Jenkins, Pee Dee Experiment Station, Florence, S. C.
Stoneville 2B—Stoneville Pedigreed Seed Company, Stoneville, Miss.
Stoneville 2B-2492—Stoneville Pedigreed Seed Coempany, Stoneville, Miss.
Stoneville 5A—Stoneville Pedigreed Seed Company, Stoneville, Miss.
Stoneville 62—Oklahoma Agricultural Experiment Station, Stillwater, Okla.
Smith 78—McQueen Smith Farms, Prattville, Ala.
Stonewilt—W. W. Wannamaker, St. Mathews, S. C.
Tidewater x 45-210-515—Northeast Louisiana Experiment Station, St. Joseph, La.
Wilds—Coker's Pedigreed Seed Company, Hartsville, S. C.
White Gold Wilt—Marett's Farm and Seed Company, Westminister, S. C.
White Gold Strain 5—Marett's Farm and Seed Co., Westminister, S. C.
Watson's Mebane—Grown in cooperation with the U. S. D. A. for spinning trials.

Each test received the recommended fertilizer treatment and normal cultivation for good plant growth. Each year harmful cotton insects were present and control measures were required at each station. Frequent showers during June, July, and August many times minimize the effectiveness of insecticides as control measures. The growers who adequately protect their crops during these months can expect to have a fair return from their cotton crop. It was further noted that if normal or above normal rain fell during the months of July and August, the varieties tested frequently did not produce the highest acre yield of lint on the richer river bottom soils.

The mean yields of the varieties at each station have been summarized in Tables 1, 3, 5, 7 and 9. Tables 2, 4, 6, 8 and 10 present a summary of comparable mean lint yields of varieties that were not grown every year. The comparable yields* of these varieties are obtained as illustrated at the bottom of Tables 2, 4, 6, 8 and 10. The correction factors were obtained from the mean acre yields of the varieties that were grown in the period of years summary as shown at each station. This was done by substituting in the following equation:

$$\overline{X} - Xy = C$$

Where $\overline{X}$ is the grand average of varieties that have been grown every year in the period of years summary; Xy is the mean of the yth year, and C is the correction factor.

The correction factor for each year was then added, algebraically, to the yield values for all varieties within that year. This gives a set of estimated comparable yields, as shown in Tables 2, 4, 6, 8 and 10.

SOUTH LOUISIANA TESTS

F. W. Self, Jack E. Jones and John R. Cotton

Cotton Variety Averages of Tests, 1947-1950, Baton Rouge, La.

The tests at Baton Rouge were located on the Louisiana Experiment Station Perkins Road Farm three miles east of Baton Rouge, La. The soil type is Olivier silt loam. High rates of complete fertilizer were used in the tests each year. The tests received 500 pounds of 6-8-8 fertilizer, with 50 pounds of sodium nitrate as a side dressing, in 1947; 550 pounds of 6-8-8 fertilizer, with 150 pounds of sodium nitrate as a side dressing, in 1948; 800 pounds of 6-8-8 fertilizer in 1949; 600 pounds of 6-8-8 fertilizer in 1950.

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* Patterson, R. E., "A Method of Adjusting for Calculating Comparable Yields in Variety Tests," Agronomy Journal, Volume 42: 509-511, 1950.

TABLE 1. Four-Year Averages of Cotton Varieties Tested on the Louisiana Experiment Station Perkins Road Farm, Baton Rouge, La., 1947-1950.

	Pounds of Lint Per Acre				4-Year Average			
	1947	1948	1949	1950	Lint per acre	Lint per cent	Staple length in 1/32″	Boll Size
Deltapine 15....	393	539	342	648	481	40.0	34	85
Louisiana 33	506	541	356	470	468	37.4	33	83
Empire	461	534	279	586	465	37.2	34	70
Miller 610	397	414	359	645	454	37.7	32	76
Coker 100 WR....	416	505	336	537	449	36.5	35	77
Smith 78	450	429	323	536	435	36.1	35	81
Stonewilt ...	446	487	261	537	435	36.7	34	81
Plains	457	421	254	601	433	37.5	34	76
Coker 100 Staple..	416	484	336	478	429	35.3	35	83
Delfos 651	355	553	262	497	417	35.7	36	84
Stoneville 2B ..	408	431	268	518	406	35.8	35	73
Bobshaw	413	466	290	432	400	35.8	34	81
Mean lint per acre	427	484	306	540	439			
Difference for significance....	78	94	58	77	44			

TABLE 2. Mean Yields By Years and Estimated Adjusted* Average Acre Yield of Lint of Cotton Varieties That Were Grown Less Than Four Years on the Louiisana Experiment Station Perkins Road Farm, Baton Rouge, La.

	Pounds of Lint per Acre						Average		
	1947	1948	1949	1950	Avg.	Adjusted Avg.	Lint per cent	Staple length in 1/32″	Boll size
Correction factors	+12	−45	+133	−101					
Fox	490	483	..	617	530	485	36.9	35	84
Mebane 6801	..		.	578	578	477	38.7	32	64
Deltapine 14	451	535	..	...	493	477	40.5	34	93
White Gold Wilt ..		...	328	588	458	474	36.2	34	76
Marett's E 1-21-2-3-10..	..	.	373	538	456	472	35.7	35	68
Delfos 9169	427	518	339	..	428	461	36.1	35	78
Stoneville 62	459	463	...	...	461	445	38.5	32	87
Louisiana 310	424	496	..	...	460	444	38.8	32	83
Louisiana 47	456	443	314	..	404	438	38.1	32	85
White Gold Strain 5	..	..	279	516	398	414	35.1	35	71
Cobal T-416	410	444	...	..	427	411	36.7	34	82
Paula	409	463	463	...	445	400	35.3	35	78
Stoneville 5A	357	432	309		366	399	36.3	34	82
Delfos 444	...	360	314	471	382	377	31.8	36	93
C. R. I.	...	..	..	460	460	359	37.2	34	68
Wilds	...	...	.	380	380	279	31.6	38	73
Sealand 542	...	199	242	284	242	237	31.4	42	82

* Estimated adjusted mean yields. The average acre yield of Fox, for example, was obtained as follows: (490 + 12) + (483 — 45) + (617 — 101) / 3= 485.

East Baton Rouge Parish receives annually, as an average, 59 inches of rainfall. Forty-five per cent of this total amount falls, as an average, during the months of April through August. For the five-month period, the Baton Rouge rainfall was 30.6 per cent below normal in 1947; 39.3 per cent below normal in 1948; 2.5 per cent below normal in 1949, and 1.46 per cent below normal in 1950.

The tests were planted on May 1 in 1947; April 28 in 1948; April 29 in 1949; and April 27 in 1950. Two plants per hill were spaced approximately 16 inches apart in the row.

The five varieties Deltapine 15, Louisiana 33, Empire, Miller 610, and Coker 100 WR were the highest yielding varieties, as an average, of the twelve in the four-year comparisons.

In certain years some of the varieties failed to rank in the high average, but they yielded better in other years, which held up their average yield of lint. These high producing varieties differ slightly in other characters, such as lint per cent, boll size, staple length, and resistance to Fusarium wilt.

In the group of varieties that were grown for a portion of the four years, the estimated adjusted mean yields of Delfos 9169, Fox, Deltapine 14, Stoneville 62, White Gold Wilt, Mebane 6801, and Marett's E-1-21-2-3-10 indicated that these varieties would have yielded as well as the five leading varieties if they had been grown during the same years. The estimated adjusted mean comparison was prepared for those who are interested in comparing the potential of certain varieties that were not grown in all the years. It may be noted that most of these varieties yielded approximately the same amount of lint per acre, particularly when one considers the over-all average acre yield of lint.

NORTHEAST LOUISIANA TESTS

C. B. Haddon, Superintendent

Cotton Variety Averages of Tests, 1947-1950, St. Joseph, La.

The tests at St. Joseph were conducted on the Northeast Louisiana Experiment Station approximately three miles north of St. Joseph, La. They were conducted on Commerce silt loam of dark brownish gray Mississippi river bottom soil. The cotton variety tests were rotated on land following soybeans. In 1947, 100 pounds of sodium nitrate per acre was applied before planting and after the cotton had been thinned to a stand; in 1948, 190 pounds of sodium nitrate per acre was used; in 1949, 200 pounds of sodium nitrate per acre was applied as a side dressing; in 1950, 145 pounds of ammonium nitrate per acre was applied to the test.

St. Joseph receives annually, as an average, 21.99 inches of rainfall during the five months of April through August. In 1947, the rainfall was approximately 12 per cent below normal; in 1948,

TABLE 3. Four-Year Averages of Cotton Varieties Tested on the Northeast Louisiana Experiment Station, St. Joseph, La., 1947-1950.

	Pounds of Lint Per Acre				4-Year Average			
	1947	1948	1949	1950	Lint per acre	Lint per cent	Staple length in 1/32″	Boll size
Deltapine 15	816	1177	681	1038	941	39.8	35	74
Delfos 9169	821	1226	589	1008	911	35.8	36	67
Stoneville 5A	762	1093	579	1029	866	36.0	35	71
Coker 100 WR	758	1170	612	903	861	35.7	35	68
Empire	751	1113	632	885	845	35.8	35	57
White Gold Wilt.	809	1054	584	917	841	36.9	35	67
Coker 100 Staple.	661	1143	531	1008	836	34.5	37	73
Bobshaw	758	1008	542	987	824	35.1	35	69
Stoneville 2B	774	926	629	934	816	35.5	36	66
Delfos 651	798	1202	604	651	814	35.2	37	72
Delfos 444	642	1082	633	833	798	31.6	38	77
Wilds	465	810	436	729	610	32.0	41	66
Mean lint per acre	734	1084	588	914	830			
Difference for significance	83	103	40	70	54			

TABLE 4. Mean Yields by Years and Estimated Adjusted* Average Acre Yield of Lint of Cotton Varieties That Were Grown Less Than Four Years on the Northeast Louisiana Experiment Station, St. Joseph, La.

	Pounds of Lint per Acre						Average		
	1947	1948	1949	1950	Avg.	Adjusted Avg.	Lint per cent	Staple length in 1/32″	Boll size
Correction factors	+96	−254	+242	−84					
Fox	...	1166	..	1041	1103	934	36.0	36	75
Deltapine 14	800	1206	...		1003	924	40.2	35	73
Plains	..	..	...	972	972	888	36.6	35	65
Louisiana 33	..	1129	631	913	891	859	36.0	35	73
White Gold Strain 5	...	1098	574	986	886	854	34.5	35	66
Paula	..	...	538	987	763	842	33.7	36	63
C. R. I.	.	...	..	921	921	837	38.1	34	55
Stoneville 62	702	..	..	.	702	798	38.0	34	68
Marett's E 1-21-2-3-10	...	1033	..	892	963	794	34.9	37	64
Mebane 6801	...	...	..	876	876	792	38.3	32	58
Tidewater x 45-210-515	..		459	708	584	663	32.3	41	72
Acala 4-42	..	981	322	..	652	646	37.3	36	59
Rowden 41B	...	760	513	...	637	631	34.9	34	55
Acala 1517-W	...	932	326		629	623	35.0	36	63
Sealand 542	...	785	432	564	594	559	31.0	44	63
Watson's Mebane	..	766	315	...	541	535	36.0	35	54

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* Estimated adjusted mean yields. The average acre yield of Deltapine 14, for example, was obtained as follows: (800 + 96) + (1206 − 254) / 2 = 924.

28 per cent below normal; in 1949, 14.4 per cent below normal, but in 1950, it was approximately 40 per cent above normal for the five months.

The highest acre yields were produced when the area received 28 per cent below normal rainfall. The test, as an average, produced longer fiber when it received an excess of 40 per cent of its normal rainfall for the April through August period.

The tests were planted on April 28 in 1947; on April 29 in 1948; on April 26 in 1948; and on April 27 in 1950. Two plants per hill were spaced approximately 12 inches apart in the row.

Deltapine 15 and Delfos 9169 were the two highest yielding varieties, as an average, of the twelve varieties in the four-year comparison. Deltapine ranked first in 1949 and 1950, but second in 1947 and 1948. Delfos 9169 ranked first in 1947 and 1948, seventh in 1947, and tied Coker 100 Staple for second in 1950. The average over-all acre yield of lint for these two varieties shows that they do not differ significantly in their yielding ability.

In the group of varieties that were grown for a portion of this four-year period, the estimated mean adjusted yields of Fox, Deltapine 14, and Plains indicate that these varieties yielded relatively as well as the two that were high in the four-year comparisons.

In the long staple group, Tidewater x 45-210-515 and Wilds out-yielded Sealand. Sealand 542 produced the longest fiber of all varieties tested.

NORTHWEST LOUISIANA TESTS

J. Y. Oakes, Superintendent

Cotton Variety Averages of Tests, 1948-1950, Bossier City, La.

The tests at Bossier City were conducted on the Red River Valley Experiment Station approximately eight miles south of Bossier City, La. The soil type is Yahola very fine sandy loam Red River bottom soil. The tests received 50 pounds of nitrogen per acre in 1948; 40 pounds of nitrogen per acre in 1949; and 400 pounds of 6-8-8 fertilizer per acre in 1950.

The Bossier City area receives annually, as an average, 40 inches of rainfall. The area receives approximately 18.59 inches during the five months of April through August. The area received approximately 21 per cent below normal in 1948; 35 per cent below normal in 1949; and an excess of 40 per cent in 1950. The highest average acre yield and the longest fiber were produced when the area received the excess rainfall in the five-month period.

The tests were planted on May 5 in 1948; on April 25 in 1949; and on April 28 in 1950. Two plants per hill were spaced approximately 16 inches apart in the row.

TABLE 5. Three-Year Averages of Cotton Varieties Tested on the Red River Valley Experiment Station, Bossier City, La., 1948-1950.

	Pounds of Lint per Acre			3-Year Average			
	1948	1949	1950	Lint per acre	Lint per cent	Staple length in 1/32″	Boll size
Deltapine 15	724	717	890	777	39.6	35	76
Empire	836	698	724	753	35.2	35	66
Coker 100 Staple	732	637	882	750	34.9	36	77
Coker 100 WR	785	526	876	729	35.1	35	74
Plains	675	571	867	704	36.1	34	70
Bobshaw	549	507	933	663	34.8	34	75
Delfos 9169	631	558	785	658	34.2	36	71
Stonewilt	627	575	761	654	34.4	34	76
Louisiana 33	648	641	658	649	36.5	34	76
Stoneville 2B	696	473	760	643	34.9	35	72
Mean lint per acre	690	590	814	698			
Difference for significance	127	141	*	92			

* Differences not significant.

TABLE 6. Mean Yields by Years and Estimated Adjusted* Average Acre Yield of Lint of Cotton Varieties That Were Grown Less Than Three Years on the Red River Valley Experiment Station, Bossier City, La.

	Pounds of Lint per Acre					Average		
	1948	1949	1950	Avg.	Adjusted Avg.	Lint per cent	Staple length in 1/32″	Boll size
Correction factors	+8	+108	−116					
Delfos 651	..	696	908	802	798	36.0	38	70
Fox	759	...	892	826	772	36.5	35	82
White Gold Wilt		600	883	742	738	36.2	35	67
Stoneville 62	718	...	..	718	726	37.0	32	82
Miller 610	675	..	882	779	725	35.4	31	79
Louisiana 47	683	647	...	665	723	35.5	33	84
Delta Smooth Leaf	...	590	...	590	698	40.4	35	66
White Gold Strain 5	..	587	801	694	690	35.3	35	66
Delfos 444	..	622	759	691	687	31.6	38	85
Smith 78	635	.	790	713	659	35.5	35	75
Mebane 6801	...	...	750	750	642	40.0	33	63
C. R. I.	...	...	747	747	639	39.5	33	60
Deltapine 14	622	...	..	622	630	39.6	33	88
Paula	..	...	728	728	620	34.6	36	61
Stoneville 5A	589	...	747	668	614	37.5	34	80
Stoneville 2B-2492	596	...	576	586	532	34.9	35	66
Wilds	...	...	635	635	527	32.2	41	67
Tidewater x 45-210-515	...	270	582	426	422	32.9	41	71
Sealand 542	435	...	413	424	370	31.5	41	71

* Estimated adjusted mean yields. The average acre yield of Delfos 651, for example, was obtained as follows: (696 + 108) + (908 − 116) / 2 = 798.

Deltapine 15, Empire, Coker 100 Staple, Coker 100 WR, and Plains were the five highest yielding varieties, as an average, of the ten varieties in the three-year comparison. These five varieties varied some in their rank in certain years, but they produced relatively high acre yield of lint each year.

In the group of varieties that were grown for a portion of the three years, the estimated adjusted mean yields of Delfos 651 and Fox indicate that these two varieties yielded relatively as well as any of the five high producing varieties in the three-year comparison.

In the long staple group, Wilds out-yielded Tidewater x 45-210-515 and Sealand in the adjusted average comparison. They all produce 1 and 9/32 inches staple length.

NORTH LOUISIANA EXPERIMENT STATION TESTS

R. S. Woodward, Superintendent

Cotton Variety Averages of Tests, 1947, 1948, and 1950, Calhoun, La.

The tests at Calhoun were conducted on the North Louisiana Experiment Station at Calhoun, La. They were located on well-drained Orangeburg sandy texture type soil. This soil is highly productive in years of ample rainfall. The tests received 350 pounds of 4-8-8 fertilizer in 1947; 250 pounds of 5-10-5 fertilizer in 1948; and 450 pounds of 6-8-8 fertilizer in 1950.

The Calhoun area receives, as an average, 21.08 inches of rainfall during the months of April through August. In 1947, the station received approximately 11 per cent above normal rainfall; in 1948, 38 per cent below normal; and in 1950, approximately 52 per cent above normal rainfall during this period. The highest average acre yield of lint and the longest average staple length were produced when the test received the highest rainfall for this five-month period.

The tests were planted on April 26 in 1947; on April 21 in 1948; and on May 9 in 1950. Two plants per hill were spaced approximately 16 inches apart in the row.

The nine varieties in the three-year summary did not differ significantly in their mean yielding ability. In 1947, Louisiana 33, Smith 78, Stoneville 2B, Plains, and Stoneville 5A were the best yielding varieties. These varieties do not show this superiority when one compares the over-all mean yield of the nine varieties for three years at this station.

TABLE 7. Three-Year Averages of Cotton Varieties Tested on the North Louisiana Experiment Station, Calhoun, La., 1947, 1948, 1950.

	Pounds of Lint per Acre			3-Year Average			
	1947	1948	1950	Lint per acre	Lint per cent	Staple length in 1/32″	Boll size
Smith 78	224	490	659	458	35.7	33	85
Stoneville 2B	211	501	656	456	36.0	33	81
Louisiana 33	255	517	595	456	37.6	32	84
Empire	186	531	636	451	35.7	33	73
Deltapine 15	190	505	643	446	40.2	33	88
Plains	202	512	615	443	36.8	33	81
Stoneville 5A	196	496	613	435	35.2	33	81
Miller 610	159	545	582	429	36.6	32	75
Coker 100 WR	172	511	527	403	35.4	34	79
Mean lint per acre...	199	512	614	442			

The variation within blocks, strains, and years was so great that no significance can be attached to the average difference of lint per acre for these nine varieties. However, a difference of 62 pounds of lint per acre between varieties in 1947 is barely significant.

TABLE 8. Mean Yields by Years and Estimated Adjusted* Average Acre Yield of Lint of Cotton Varieties That Were Grown Less Than Three Years on the North Louisiana Experiment Station, Calhoun, La.

	Pounds of Lint per Acre					Average		
	1947	1948	1950	Avg.	Adjusted Avg.	Lint per cent	Staple length in 1/32″	Boll size
Correction factors	+243	−70	−172					
Fox	...	535	636	586	464	36.1	35	79
Louisiana 47	226	517	...	372	458	36.5	31	95
Miller 919	203	511	...	357	444	37.5	30	76
Deltapine 14	199	...	...	199	442	42.9	32	96
Delfos 9169	194	...	620	407	442	37.1	34	77
Louisiana 310	185	524	...	355	441	37.4	30	91
Coker 100 Staple..	163	...	621	392	427	35.0	34	83
Bobshaw	170	...	543	357	392	36.4	32	79
White Gold Wilt ..	140	...	535	338	373	36.8	32	80

* Estimated adjusted mean yields. The average acre yield of Fox, for example, was obtained as follows: (535 — 70) + (636 — 172) / 2 = 464.

NORTH LOUISIANA HILL FARM EXPERIMENT STATION TESTS

D. M. Johns, Superintendent

Cotton Variety Averages of Tests, 1948-1950, Homer, La.

The tests at Homer were conducted on the North Louisiana Hill Farm Experiment Station approximately three miles south of Homer, La. The tests were located on well-drained Ruston type soil.

The tests received 900 pounds of 4-8-8 fertilizer, with 20 pounds of nitrogen as a side dressing, in 1948; 500 pounds of 8-8-8 fertilizer and 75 pounds of ammonium nitrate with 25 pounds of 50 per cent muriate of potash as a side dressing in 1949; 600 pounds of 8-8-8 fertilizer and 150 pounds of nitrate of soda per acre as a side dressing in 1950.

The Homer area receives, as an average, 21.55 inches of rainfall from April through August. The Minden weather station(the closest weather records) reported approximately 49 per cent deficiency in 1948; 8 per cent deficiency in 1949; and 29 per cent excess in 1950, during this five-month period.

The tests were planted on April 21 in 1948; on April 18 in 1949; and on May 15 in 1950. Two plants per hill were spaced 16 inches apart in the row.

TABLE 9. Three-Year Averages of Cotton Varieties Tested on the North Louisiana Hill Farm Experiment Station, Homer, La., 1948-1950.

	Pounds of Lint per Acre			3-Year Average			
	1948	1949	1950	Lint per acre	Lint per cent	Staple length in 1/32″	Boll size
Empire	368	810	301	493	39.2	33	71
Deltapine 15	302	774	297	458	40.8	33	87
Louisiana 33	335	768	231	445	38.1	32	88
Stoneville 2B	362	745	216	441	37.1	34	78
Stonewilt	343	633	299	425	38.0	33	83
Mean lint per acre	342	746	268	452			

The variability within blocks, strains, and years was so great that no significance can be attached to the above difference of lint per acre.

TABLE 10. Mean Yields by Years and Estimated Adjusted* Average Acre Yield of Lint of Cotton Varieties That Were Grown Less Than Three Years on the North Louisiana Hill Farm Experiment Station, Homer, La.

	Pounds of Lint Per Acre					Average		
	1948	1949	1950	Avg.	Adjusted Avg.	Lint per cent	Staple length in 1/32″	Boll size
Correction factors	+110	−294	+184					
Fox	...	...	336	336	520	40.6	34	84
Plains	...	745	314	530	475	40.1	34	70
Smith 78	300	813	...	557	465	35.4	34	83
Coker 100 WR	...	766	270	518	463	39.5	35	79
Bobshaw	...	789	245	517	462	37.5	34	76
Miller 610	324	...	303	314	461	39.0	31	83
White Gold Strain 5	...	761	253	507	452	38.6	33	74
White Gold Wilt	...	708	436	572	436	38.8	33	81
Coker 100 Staple	...	666	310	488	433	38.7	37	77
Deltapine 14	312	...	...	312	422	38.5	32	107
Delfos 651	...	653	275	464	409	38.2	36	81
Stoneville 5A	358	635	...	497	405	36.4	33	88

* Estimated adjusted mean yields. The average acre yield of Plains, for example, was obtained as follows: (745 — 294) + (314 + 184) / 2 = 475.

The five varieties in the three-year averages did not differ significantly in their mean yielding ability. The difference between any of the over-all means of the five varieties was small, but Empire yielded relatively more than any of the other five varieties.

SUMMARY

A summary of the over-all performance of four cotton varieties that have been grown for four years at Baton Rouge and St. Joseph and for three years at Bossier City showed them as ranking in the following order: Deltapine 15, Coker 100 Staple, Empire, and Coker 100 WR. Deltapine 15 was the leading variety at three stations, but the other three varieties varied in their relative rank at the separate stations. The leading varieties at Baton Rouge in four years of testing were Deltapine 15, Louisiana 33, Empire, Miller 610, and Coker 100 WR. The leading varieties at St. Joseph in four years of testing were Deltapine 15 and Delfos 9169. These two varieties averaged over 900 pounds of lint per acre. In three years of testing, Deltapine 15, Empire, Coker 100 Staple, Coker 100 WR, and Plains were the five leading varieties at Bossier City. These five varieties averaged over 700 pounds of lint per acre. An average of the long staple variety data at St. Joseph and Bossier City showed that Wilds produced an over-all average of 569 pounds of lint per acre with a staple length of 1⅝ inches. Tidewater x 45-210-515 produced an average of 543 pounds of lint per acre and 1-9/32 inches staple length. Sealand produced 484 pounds of lint per acre and 1 11/32 inches staple length. Sealand made its highest yields and produced the longest fiber at the St. Joseph station.

From the average yields for the three years of testing at the North Louisiana Experiment Station and the North Louisiana Hill Farm Experiment Station at Homer, significant differences among the varieties tested at these stations were not found.

Part II

Louisiana Certified Cotton Seed Study

The question frequently arises as to whether cotton seed that has been grown and certified in Louisiana is equal to breeder's or to certified seed from adjoining states.

The 1948 tests contained five sources of seed, while the 1949 tests contained nine sources of seed. Eight of the nine entries in the 1949 tests were secured from Louisiana certified seed growers. The check was breeder's seed from the same variety. These tests were located at the Northeast Louisiana Experiment Station at St. Joseph and at the Red River Valley Experiment Station at Bossier City, La.

The Mississippi Experiment Station* has conducted extensive tests with five commercial cotton varieties and certified seed from the same varieties. These Mississippi experiments showed a small decrease in lint per cent as the years of reproduction increased. Other changes were less marked, but the number of naked seeds increased after the third generation of reproduction. Changes in seed cotton yields, lint yields, and staple length were too small and subject to too many factors to be properly evaluated.

The results of the Mississippi tests support the existing belief that the chief cause of cotton varietal deterioration is the mixing of varieties in fields, in places of storage, or at the gins.

The germination quality of seed is affected by many factors, such as weather damage in the field before the cotton has been harvested. This reduction in germination and vigor varies from season to season. A comparative experiment of breeder's seed with certified seed would be influenced by localized conditions under which the seed had been produced the previous year. The genetic variation in present day improved cotton varieties is small, and this difference is difficult to measure in field experiments. The variation in germination quality and vigor of cotton seed is frequently of a localized nature. Adverse climatic conditions in the field before the cotton seed was harvested may influence the experiment more than genetic variation. Because of their inability to compete with healthy plants, the weakened plants produce less cotton than thrifty plants of similar genetic purity. The normal germination per cent is not a measure of the vigor of the seed but a measure of the total number of seed that germinate under favorable environment. All of the cotton seed samples placed in these 1948 and 1949 experiments had 80 per cent or better germination. It was assumed that breeder's seed and certified seed vigor was on an equal basis, as excellent stands and growth were secured from each entry in the experiments.

The five lots of seed were mixed thoroughly, divided, and planted in single-row, randomized plots of four replications in 1948 at the two locations. These tests received normal attention, and seed cotton was harvested from each replicated plot to determine the yield of cotton per acre. Lint per cent for each source of seed was determined by ginning ten samples of ten bolls from each plot at Bossier City. Lint samples from the St. Joseph test were not collected in 1948.

The average of these two 1948 comparative experiments indicates that first- and second-year certified seed yielded equally as well as breeder's seed.

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* O'Kelley, J. F. Degeneration Within Cotton Varieties. Journal American Society of Agronomy. 34:782-796. September 1942.

TABLE 11. Relative Yielding Values of Breeder's Seed, Mississippi Certified, and Louisiana Certified of Deltapine 15 Cotton Seed Tested on the Red River Valley Experiment Station, Bossier City, La., 1948.

	Pounds of Seed Cotton per Acre	Pounds of Lint Per Acre	Lint Per Cent	Staple length in 1/32″
Breeder's seed	1806	717	39.7	34
First-year Mississippi certified seed	1473	548	37.2	35
Second-year Mississippi certified seed	1774	699	39.4	34
First-year Louisiana certified seed	1840	734	39.9	34
Second-year Louisiana certified seed	1940	743	38.3	35

The seed from different sources did not differ significantly from breeder's seed in yield of lint per acre, lint per cent, or staple length.

TABLE 12. Relative Yielding Values of Breeder's Seed, Mississippi Certified, and Louisiana Certified of Deltapine 15 Cotton Seed Tested on the Northeast Louisiana Experiment Station, St. Joseph, La., 1948.

	Pounds of Seed Cotton per Acre
Breeder's seed	2977
First-year Mississippi certified seed	3059
Second-year Mississippi certified seed	2935
First-year Louisiana certified seed	3061
Second-year Louisiana certified seed	3151

The 1949 experiments in which breeder's seed were compared with eight samples from Louisiana first-year certified cotton seed gave the same comparative relationship as the 1948 experiments, i. e., there were no significant differences between breeder's seed and these eight first-year Louisiana certified Deltapine 15 samples.

These experiments were of a preliminary nature and the conclusions that can be drawn are limited. The changes that take place in first- and second-year certified seed of improved cotton varieties that are being used today are so small that cotton growers do not necessarily need to replace their seed stocks with breeder's seed until they have certified their seed two years. The storing, ginning, delinting, and treating of cotton requires special care to avoid mechanical mixtures. These preliminary tests show that certified seed growers who meet the requirements of the certifying agency can produce first- and second-year certified seed with yielding ability equal to that of breeder's seed of the same variety. A sample of seed that has been subjected to heavy weather damage which causes a low germination, obviously, would not be equal in value to one that had a high germination, whether it be breeder's seed or certified seed.

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Yield Trials With Corn Hybrids In Louisiana, 1948-51

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D. M. Johns, Superintendent, North Louisiana Hill Farm Experiment Station, Homer.

R. S. Woodward, Superintendent, North Louisiana Experiment Station, Calhoun.

J. Y. Oakes, Superintendent, and L. L. McCormick, Assistant Agronomist, Louisiana Red River Valley Experiment Station, Bossier City.

H. D. Ellzey, Superintendent, Southeast Louisiana Dairy and Livestock Experiment Station, Franklinton.

A. G. Killgore, Associate Agronomist, Louisiana Agricultural Extension Service, and V. E. Green and Jack D. DeMent, Assistant Agronomists, Louisiana Agricultural Experiment Station, collected the data in Lafourche Parish in 1948, 1949, and 1950, respectively.

The writer obtained the data at Lake Providence, Oberlin, Marksville, Mansura, and St. James.

YIELD TRIALS WITH CORN HYBRIDS IN LOUISIANA, 1948-51

H. W. Ivy, Jr.

INTRODUCTION

The increased yield of corn per acre during the period 1949-51 as shown in the following table indicates some progress in corn production. Prior to 1949 Louisiana had never averaged as much as 20 bushels of corn per acre. The 1949-51 three-year period average is 23.5 bushels per acre. Undoubtedly, the increased use of hybrids and better fertilization played important roles in the increased average acre yield of corn in Louisiana.

Corn Acreage and Yield 1942-51

Year	Acreage harvested, 1000 acres	Average acre yield, bushels
1942	1,296	17.0
1943	1,270	16.0
1944	1,168	14.0
1945	1,075	19.5
1946	1,000	15.0
1947	960	14.5
1948	922	18.5
1949	802	23.0
1950	866	23.0
1951	762	24.5

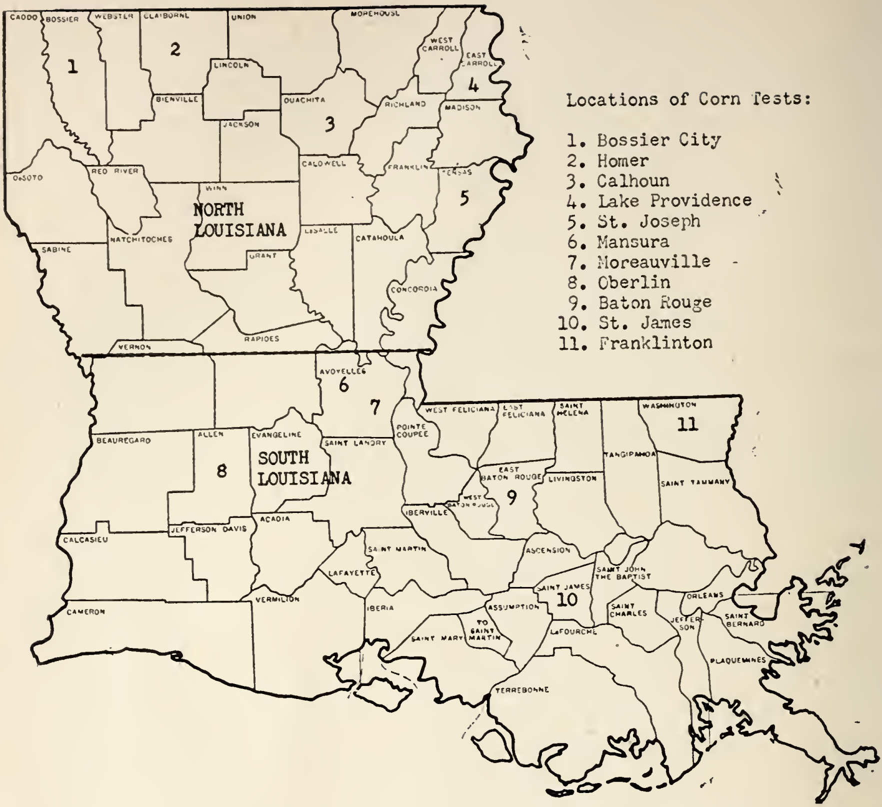
Louisiana farmers plant about one-fifth of their harvested cropland in corn. The planting of adapted hybrids, which yield 20 to 30 per cent more than the better open-pollinated varieties, therefore, means millions of extra bushels of corn to the farmers of Louisiana.

The purpose of corn yield trials in Louisiana is to determine the best adapted hybrids. Hybrids have limited areas of adaptation, and very seldom will a hybrid developed under conditions very different from those in the South perform satisfactorily in Louisiana.

Experimental Methods

The corn yield trials are conducted in different sections of the state in order to determine adaptability of the various hybrids to the different soil, climatic, and other environmental conditions.

The usual size of the test plot is two 40- or 42-inch rows 30 to 50 feet long. The tests in Lafourche and St. James parishes had plots consisting of two six-foot rows 50 feet long. At the Experiment Stations the tests have 25 entries or fewer. The tests located on farms usually have 10 entries or fewer. A randomized block



Locations of Corn Tests:

1. Bossier City
2. Homer
3. Calhoun
4. Lake Providence
5. St. Joseph
6. Mansura
7. Moreauville
8. Oberlin
9. Baton Rouge
10. St. James
11. Franklinton

arrangement is used with four or five replications. All tests are hand planted at the rate of three or four seeds per hill and later thinned to one or two stalks per hill as desired in the particular test. Planting and harvesting are under the supervision of a representative of the Agricultural Experiment Station.

The ear height is the approximate number of inches from the ground to the point where the upper ear is attached to the stalk. The plant height is measured to the base of the tassel.

In grading husks a grade of good denotes a husk that extends at least two inches beyond the ear tip and is tight. A fair husk extends from one to three inches beyond the ear tip and is of medium tightness. A poor husk is loose and usually extends less than two inches beyond the ear.

Sound ears are those free of rot and weevil damage at harvest.

In determining the percentage of erect plants, all plants leaning more than 30 degrees and those broken below the ear are counted as lodged plants. The percentage erect is then calculated.

Significant difference is given at the foot of each table. However, it is not given for the period-of-year summaries. It is not possible to determine the yielding ability with absolute accuracy on account of variation in soil fertility and other uncontrolled variables. A significant difference is a difference great enough to have odds of 19 to 1 against its being due to chance variation alone. Entries varying this much actually performed differently in the particular test.

Experimental Results

In selecting a hybrid the performance for a period of years is more important than any one year's results. A hybrid may be outstanding one year, while under other seasonal conditions it may not prove as satisfactory. A farmer should study the test on the station or farm nearest his farm. This should enable him to choose the best adapted hybrids. Tables 1, 2, 3, 4, 5, and 6 give the four-year period averages for hybrids tested at Baton Rouge, St. Joseph, Homer, Calhoun, and Bossier City, and in Lafourche and St. James parishes.

Dixie 11, a white hybrid, is adapted to North Louisiana. It was the highest yielding hybrid for the four-year period 1948-51 at St. Joseph, Homer, Calhoun, and Bossier City. In the test at Lake Providence it was second in yield only to Dixie 18. Dixie 11 lodges considerably under some conditions.

La. 468, a white hybrid, is adapted to North Louisiana. It is very similar to Dixie 11. Three of the four inbred parents of Dixie 11 and La. 468 are the same. One-half of the La. 468 cobs will be white and the other half red.

Funk's G-780W is a white hybrid that has performed well at Calhoun and Bossier City. At St. Joseph and Lake Providence it has not shown yielding ability equal to that of Dixie 11. Funk's G-785W is a white hybrid recently released to replace 780W. Its performance was comparatively good at Lake Providence in 1951.

Coker's Coastal 811 has more resistance to lodging than any other hybrid tested in Louisiana. This hybrid is white and has a semi-flint grain which shows good rice weevil resistance. Coker's Coastal 811 works well for mechanical harvesting.

Dixie 33 is a white hybrid high in yielding ability. It yielded particularly well at St. Joseph in 1951. This hybrid does not have ample husk for most Louisiana conditions unless harvested early.

Dixie 18 has proved to be a very good yellow corn in North and South Louisiana. The husk coverage and quality are excellent as shown by Figure 1. It has more resistance to lodging than any other yellow corn tested in Louisiana. At St. Joseph and Lake Providence its standing ability was equal to that of Coker's Coastal 811. However, it ranked second in erectness as compared to Coker's 811

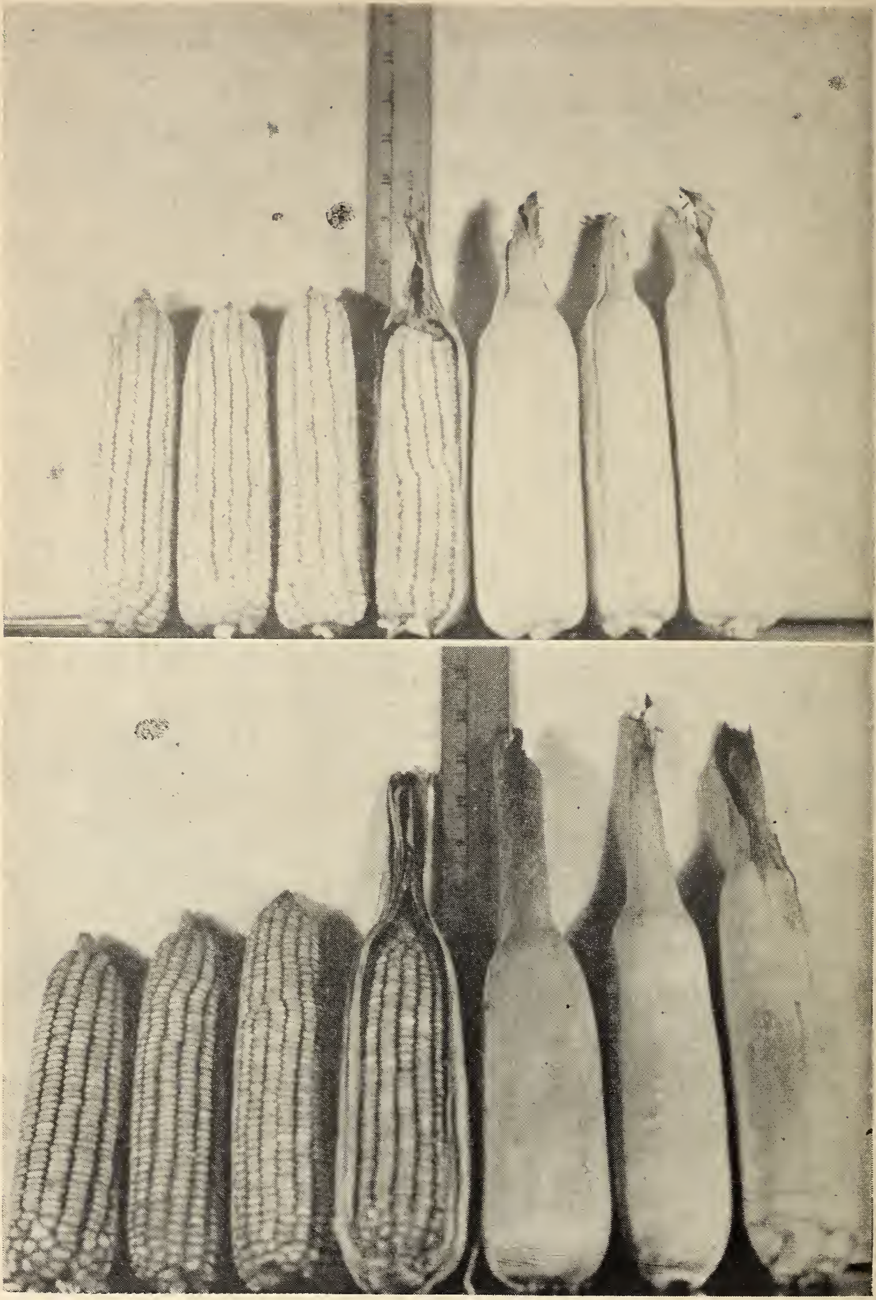


FIG. 1—Above photographs show ear type and husk protection of Dixie 18, bottom, and La. 468, top. The long, tight husk of Dixie 18 is classified as good. The shorter, medium-tight husk of La. 468 is classified as fair.

at Calhoun, Homer, and Bossier City. Dixie 18 grows very tall and has high ears; nevertheless it has been one of the leading hybrids in acre yield of mechanically harvested corn at St. Joseph and Bossier City. Dixie 18 is recommended for silage throughout Louisiana.

N.C. 27 is adapted to North Louisiana but the husk protection is not ample for late harvesting. This corn can best be utilized in Louisiana to hog off or to harvest early. This yellow corn is also one of the hybrids best adapted to mechanical harvesting. This quality was evident in the mechanically harvested tests at St. Joseph and Bossier City.

Dixie 22 performs very similarly to N.C. 27 and has the same area of adaptation. Like N.C. 27 its husk is not ample. Dixie 22 did not show as much weevil resistance at Baton Rouge and Calhoun as did N.C. 27. Some of the Dixie 22 ears are reddish in color.

Funk's G-714A compared favorably with Dixie 18 in yielding ability at Bossier City and Homer. At Calhoun, St. Joseph, and Lake Providence, Dixie 18 outyielded Funk's G-714A. Funk's G-714A also lodges badly as compared to Dixie 18.

La. 521 is adapted to all South Louisiana. It was the highest yielding hybrid in the tests at Mansura, Moreauville, Baton Rouge, St. James, and Oberlin in 1951. La. 521 produces more high quality corn than any other white hybrid tested in South Louisiana.

Funk's G-737 is adapted to South Louisiana. This is a yellow corn of good quality which compares favorably with Dixie 18 in yielding ability in that area. However, Dixie 18 has a higher percentage of erect plants at harvest.

Table 1—Average performance of corn hybrids in test on Olivier silt loam at Louisiana Agricultural Experiment Station, Baton Rouge, 1948-51.

	Averages				
	4-year	3-year		2-year	
Entry	Acre yield, bu.	Acre yield, bu.	Erect plants at harvest, %	Acre yield, bu.	Erect plants at harvest, %
La. 521	76.2	66.7	43	68.8	60
N.C. 27	72.1	63.6	55	66.1	73
La. 468	72.0	60.2	38	69.6	55
Dixie 18	71.3	63.0	67	63.2	82
Dixie 11	70.4	60.2	41	65.0	58
Funk's G-737	65.5	60.6	45	60.3	63
La. 1031	65.0	56.1	40	60.7	57
Hill Yellow Dent	53.5	47.8	53	51.3	68
Calhoun Red Cob	53.5	47.4	35	50.6	45
Jarvis Prolific	53.0	45.9	43	51.7	58
Funk's G-714A	...	58.4	40	63.0	53
Funk's G-780W	...	57.2	44	60.4	54
Coker's Coastal 811	...	..	..	69.7	83
Dixie 33	...	...	..	67.3	72
Dixie 22	..	...	..	66.2	67

Table 2—Average performance of corn hybrids in test on Commerce very fine sandy loam at the Northeast Louisiana Agricultural Experiment Station, St. Joseph, 1948-51.

	Averages				
	4-year	3-year		2-year	
Entry	Acre yield, bu.	Acre yield, bu.	Erect plants at harvest, %	Acre yield, bu.	Erect plants at harvest, %
Dixie 11	110.4	110.9	69	110.8	69
N.C. 27	108.5	110.9	76	112.3	80
La. 468	106.9	109.0	75	110.2	80
Dixie 18	105.8	110.7	87	108.9	88
Wood's V-125	104.3	108.0	82	108.9	83
La. 521	103.5	105.3	61	102.2	59
La. 1031	99.9	104.4	67	103.3	68
Funk's G-737	94.6	98.0	67	96.6	72
Jarvis Prolific	84.6	85.3	65	84.1	61
Hill Yellow Dent	82.9	84.9	76	83.8	75
Calhoun Red Cob	80.9	82.8	59	84.5	67
White Tuxpan	73.5	76.0	63	89.6	63
Funk's G-780W	..	107.2	71	103.2	71
Funk's G-714A	...	100.0	63	103.5	69
Dixie 33	...	...	..	116.8	86
Dixie 22	..	...	..	114.8	73
Coker's Coastal 811	..	..		105.6	86

Table 3—Average performance of corn hybrids in test on Lakeland fine sand at North Louisiana Hill Farm Experiment Station, Homer, 1948-51.

	Averages				
	4-year	3-year		2-year	
Entry	Acre yield, bu.	Acre yield, bu.	Erect plants at harvest, %	Acre yield, bu.	Erect plants at harvest, %
Dixie 11	46.2	51.2	45	54.0	24
La. 468	43.8	51.0	46	53.3	24
N.C. 27	43.4	49.2	54	52.0	31
Jarvis Prolific	35.0	40.7	51	43.0	34
Dixie 18		49.2	56	54.4	35
Funk's G-714A	..	47.6	45	51.3	26
Dixie 22	...	..	..	58.4	34
Coker's Coastal 811	..	..	..	53.8	57

Table 4—Average performance of corn hybrids in test on Orangeburg fine sand at North Louisiana Experiment Station, Calhoun, 1948-51.

	Averages				
	4-year	3-year		2-year	
Entry	Acre yield, bu.	Acre yield, bu.	Erect plants at harvest, %	Acre yield, bu.	Erect plants at harvest, %
Dixie 11	55.0	57.9	43	56.0	41
La. 468	49.2	53.3	57	51.1	53
N.C. 27	49.0	51.7	78	52.0	76
La. 521	49.0	52.5	52	52.0	56
Jarvis Prolific	40.7	43.2	67	42.2	72
Calhoun Red Cob	40.4	43.7	56	43.5	51
Hill Yellow Dent	37.7	37.8	77	37.3	74
Dixie 18	...	53.8	83	55.0	78
Funk's G-780W	...	53.0	72	51.3	72
Funk's G-714A	...	49.9	60	49.0	63
Dixie 22	...	...	..	60.0	61
Dixie 33	...	...	..	53.3	78
Coker's Coastal 811	...	...	..	51.1	96

Table 5—Average performance of corn hybrids in test on Yahola very fine sandy loam at the Louisiana Red River Valley Experiment Station, Bossier City, 1948-51.

	Averages				
	4-year	3-year		2-year	
Entry	Acre yield, bu.	Acre yield, bu.	Erect plants at harvest, %	Acre yield, bu.	Erect plants at harvest, %
Dixie 11	95.8	101.4	45	97.9	61
La. 468	92.6	99.0	53	95.8	72
N.C. 27	87.9	91.4	70	90.5	73
La. 521	83.3	89.6	51	83.9	56
Funk's G-737	82.6	89.3	53	86.6	61
La. 1031	78.7	83.1	43	78.6	48
Jarvis Prolific	74.6	80.7	61	83.1	65
Calhoun Red Cob	72.1	80.7	46	80.7	41
Hill Yellow Dent	67.2	72.0	69	68.8	67
White Tuxpan	63.4	68.0	52	68.4	51
Funk's G-780W	..	96.5	63	97.9	61
Dixie 18	...	95.6	72	94.7	74
Funk's G-714A	..	92.1	42	93.0	58
Dixie 22	...	...	..	103.9	76
Dixie 33		..		95.8	79

Table 6—Corn hybrid tests, six-foot rows, on Commerce silt loam in Lafourche and St. James parishes, 1948-51.

Entry	1951 acre yield, bu.	1950 acre yield, bu.	1949 acre yield, bu.	1948 acre yield, bu.	1948-51 av. acre yield, bu.	1949-51 av. acre yield, bu.	1950-51 av. acre yield, bu.
La. 521	52.9	86.2	83.3	54.1	69.1	74.1	69.6
Dixie 18	48.3	81.4	74.8	...		68.2	64.9
Funk's G-737	46.4	78.1	73.7	52.0	62.6	66.1	62.3
La. 1031	42.4	73.7	73.1	47.7	59.2	63.0	58.1
Funk's G-790W	..	76.3	72.7	54.8	...	...	...
Funk's G-791W	46.7	..	...		...	...	...
Hill Yellow Dent	..	63.8	59.1	50.1	...	...	...
White Tuxpan	48.6	...	50.8	47.6	...	...	...
Difference required for significance.	*	2.8	5.1	6.0			

* There was no significant difference between entries in 1951.

The tests in Lafourche and St. James parishes were planted on six-foot rows. The growing seasons in 1948 and 1951 were dry, and in both of these years moisture was the limiting factor. In years of limited moisture it is noted that there is little significant difference in the yields of any of the entries.

Louisiana 521 has been the highest yielding corn three out of four years and has the highest average yield for the two-, three-, and four-year period. Dixie 18 and Funk's G-737 have been the leading yellow hybrids.

It has not been possible to make as much corn on six-foot rows as on 40- or 42-inch rows. If sufficient acreage is planted, the purchasing of additional equipment to produce corn on rows narrower than six feet would be justified.

It is particularly important to get a good stand of corn on six-foot rows, or the use of 80 to 100 pounds of nitrogen and hybrid seed corn is not an economical practice. In order to obtain a high rate of efficiency at least 7,000 stalks per acre are necessary. This requires one stalk every 12 inches on six foot rows.

Table 7—Corn hybrid test on Commerce very fine sandy loam, St. Joseph, 1951.

Entry	Acre yield, bu.	Erect plants at harvest, %	Husk grade	Plant height, in.	Ear height, in.
Dixie 33	128.2	77	Poor	125	72
Dixie 11	119.7	45	Fair	132	70
Dixie 22	117.4	51	Poor	128	71
Wood's V-125	116.5	79	Poor	118	59
La. 468	114.6	71	Fair	127	78
Funk's G-791W	113.5	67	Good	136	78
N.C. 27	112.7	65	Poor	125	69
Wood's V-51	112.1	72	Poor	111	58
Dixie 18	111.9	78	Good	136	81
Funk's G-780W	110.9	53	Fair	128	71
Coker's Coastal 811	110.1	74	Fair	114	64
Ga. 281	109.6	36	Good	143	82
La. 1031	107.3	54	Good	133	85
La. 0015	107.3	41	Good	135	78
Funk's G-714A	106.0	51	Fair	114	69
La. 9017	105.6	78	Good	131	69
La. 9011	104.7	69	Good	127	75
La. 9012	103.7	84	Good	128	79
La. 1220	102.3	73	Good	132	77
Funk's G-721	101.8	62	Poor	117	68
Funk's G-737	100.1	51	Good	132	77
La. 521	99.3	30	Good	136	76
Calhoun Red Cob	92.1	51	Good	136	74
White Tuxpan	91.9	53	Good	145	93
Hill Yellow Dent	91.4	64	Good	141	81
Jarvis Prolific	86.1	41	Fair	121	64

A difference of 7.4 bushels per acre between any two entries is required for significance.

Table 8—Corn hybrid test on Lakeland fine sand, Homer, 1951.

Entry	Acre yield, bu.	Erect plants at harvest %	Husk grade	Plant height, in.	Ear height, in.
Dixie 22	58.6	13	Poor	80	48
La. 9017	56.2	25	Good	85	52
Funk's G-721	54.4	22	Poor	72	38
N.C. 27	53.9	9	Poor	80	48
Funk's G-714A	53.0	8	Fair	80	44
Dixie 11	51.2	9	Fair	82	50
Dixie 18	49.2	20	Good	88	58
La. 468	45.6	8	Fair	80	48
Jarvis Prolific	44.0	18	Fair	78	44
Coker's Coastal 811	43.9	35	Fair	78	36

The entries did not show significant differences in yield.

Table 9—Corn hybrid test on Orangeburg fine sand, Calhoun, 1951.

Entry	Acre yield, bu.	Erect plants at harvest, %	Husk grade	Ear wt., lb.	Sound ears, %	Plant height, in.	Ear height, in.
Dixie 22	60.5	62	Poor	.40	86	80	42
Dixie 11	59.2	36	Fair	.33	92	85	45
Dixie 18	56.8	91	Good	.34	99	88	50
La. 0015	56.2	57	Good	.36	98	80	50
La. 521	55.7	53	Good	.35	97	85	48
Dixie 33	55.6	71	Poor	.38	90	80	44
La. 1031	54.8	37	Good	.33	99	85	48
La. 1220	54.6	54	Good	.40	97	80	50
La. 468	54.2	47	Fair	.35	96	82	46
La. 9011	53.7	79	Good	.36	97	80	44
Coker's Coastal 811	52.4	97	Fair	.34	98	75	36
N.C. 27	51.9	76	Poor	.36	92	78	42
Funk's G-780W	51.3	61	Fair	.35	93	85	46
La. 9017	51.1	77	Good	.38	96	80	50
La. 9012	51.0	77	Good	.35	97	84	54
Funk's G-721	47.6	55	Poor	.40	85	78	38
Funk's G-714A	46.8	50	Fair	.29	95	78	38
Wood's V-125	45.3	84	Poor	.46	40	80	36
Wood's V-51	45.2	82	Poor	.45	47	75	30
Calhoun Red Cob	44.4	44	Good	.45	92	100	63
Jarvis Prolific	43.3	64	Fair	.33	90	78	36
Hill Yellow Dent	39.5	71	Good	.40	95	85	54
Tennessee Jarvis	35.9	74	Fair	.38	85	72	30

A difference of 8.0 bushels per acre between any two entries is required for significance.

Table 10—Corn hybrid test on Yahola very fine sandy loam, Bossier City, 1951.

Entry	Acre yield, bu.	Erect plants at harvest, %	Husk grade	Plant height, in.	Ear height, in.
Dixie 22	107.7	63	Poor	94	53
Dixie 11	98.4	54	Fair	100	56
Funk's G-791W	97.4	54	Good	108	60
Funk's G-780W	97.2	56	Fair	102	58
Funk's G-714A	96.9	36	Fair	90	50
La. 9011	95.2	56	Good	106	56
Dixie 18	94.6	59	Good	108	60
La. 468	94.1	60	Fair	90	57
La. 9017	91.4	69	Good	100	58
Funk's G-721	90.7	41	Poor	85	44
Dixie 33	90.5	73	Poor	110	60
N.C. 27	89.7	62	Poor	105	54
Coker's Coastal 811	89.7	89	Fair	102	48
La. 0015	85.7	49	Good	93	58
La. 521	85.1	38	Good	112	60
La. 9012	82.4	65	Good	98	58
La. 1220	81.5	58	Good	100	53
Ga. 281	77.8	39	Good	112	62
Jarvis Prolific	77.6	46	Fair	100	40
La. 1031	75.4	37	Good	110	72
Funk's G-737	75.2	44	Good	100	60
White Tuxpan	74.9	37	Good	120	80
Calhoun Red Cob	66.9	22	Good	106	65
Hill Yellow Dent	55.6	50	Good	104	64

A difference of 11.6 bushels per acre between any two entries is required for significance.

Table 11—Corn hybrid tests on Commerce very fine sandy loam, Lake Providence, 1950-51.

Entry	1950 acre yield, bu.	1951 acre yield, bu.	1950-51 av. acre yield, bu.	*Erect plants at harvest, %
Dixie 18	101.0	102.3	101.7	83
Dixie 11	97.4	102.0	99.7	71
La. 468	93.4	101.9	97.7	64
Funk's G-785W	...	99.8	.	
Coker's Coastal 811	92.6	98.3	95.5	85
N.C. 27	..	93.3	..	..
Funk's G-714A		91.2	.	..
Funk's G-737	..	86.2	...	
Dixie 22	94.0	.	. .	76
Kentucky 405B	87.8	...	...	78
Funk's G-714	87.0	.	. .	58
Hasting's Yellow Prolific	84.2	...	...	54
Funk's G-780W	82.4	..	..	60
White Tuxpan	79.4	..	..	67
Mosby	78.5	..	...	68
Jarvis Prolific	78.1	...	...	60
Texas 12	73.6	...	..	49
Kentucky 203	67.8	...	...	76
Broadbent 205W	67.3	...	...	69
Funk's G-50	57.1	...	...	82
Difference required for significance	5.5	7.2		

* Erectness data are from the 1950 test only.

Table 12—Corn hybrid test on Olivier silt loam, Baton Rouge, 1951.

Entry	Acre yield, bu.	Erect plants, %	Husk grade	Ear weight, lb.	Sound ears, %
La. 521	52.6	38	Good	.29	90
Coker's Coastal 811	52.4	69	Fair	.28	90
Dixie 22	52.3	47	Poor	.36	45
Dixie 11	52.3	35	Fair	.29	71
La. 468	51.9	37	Fair	.29	80
Funk's G-721	50.2	24	Poor	.34	71
Funk's G-714A	47.9	18	Fair	.29	53
Dixie 33	47.6	57	Poor	.34	44
La. 9011	47.3	62	Good	.31	76
White Tuxpan	46.2	13	Good	.38	83
Funk's G-791W	45.9	32	Good	.30	83
N.C. 27	43.9	57	Poor	.31	70
Funk's G-737	43.5	37	Good	.28	85
Dixie 18	43.2	67	Good	.29	89
Funk's G-780W	42.7	27	Fair	.26	62
La. 0015	41.6	66	Good	.29	94
La. 1220	41.2	67	Good	.32	78
La. 9017	39.5	75	Good	.27	84
Ga. 281	38.9	56	Good	.23	96
Calhoun Red Cob	38.1	20	Good	.33	86
La. 1031	37.1	34	Good	.22	91
Jarvis Prolific	36.5	38	Fair	.27	73
La. 9012	32.9	79	Good	.25	90
Hill Yellow Dent	32.3	47	Good	.29	86

A difference of 16.0 bushels per acre between any two entries is required for significance.

Table 13—Corn hybrid test on Bowie very fine sandy loam, Franklinton, 1951.

Entry	Acre yield, bu.	Entry	Acre yield, bu.
La. 9012	55.9	Ga. 281	50.0
Funk's G-791W	55.2	La. 9011	49.8
Coker's Coastal 811	54.7	La. 9017	48.6
Dixie 11	54.4	La. 468	48.3
La. 521	54.0	Dixie 18	46.3
Funk's G-737	52.0	Jarvis Prolific	45.0
La. 1220	51.6	White Tuxpan	43.7
La. 0015	50.8	Hill Yellow Dent	39.0
La. 1031	50.5	Calhoun Red Cob	36.1

Table 14—Corn hybrid tests on Yahola very fine sandy loam, Moreauville, 1950-51.

Entry	1951 acre yield, bu.	1950 acre yield, bu.	1950-51 av. acre yield, bu.
La. 521	74.5	105.2	89.9
Dixie 18	70.0	105.3	87.7
Funk's G-791W	67.4	91.7*	
Funk's G-737	64.3	92.3	78.3
La. 1031	62.0	79.0	70.5
White Tuxpan	48.8	74.9	61.9
Dixie 11	44.1	..	...
Difference required for significance	14.3	10.8	

*Funk's G-790W.

Table 15—Corn hybrid tests on Beauregard very fine sandy loam, Oberlin, 1950-51.

Entry	1951 acre yield, bu.	1950 acre yield, bu.	1950-51 av. acre yield, bu.
La. 521	57.9	88.1	73.0
Dixie 11	58.9	86.1	72.5
Dixie 18	53.1	81.5	67.3
La. 1031	51.2	70.8	61.0
Funk's G-791W	47.8	71.2*	..
Funk's G-714A	47.4	70.4	59.4
Funk's G-737	44.7	66.7	55.7
Killgore Prolific	33.3	48.4	40.8
Difference required for significance	5.2	8.2	

*Funk's G-790W.

Table 16—Corn hybrid tests on Olivier silt loam, Mansura, 1951.

Entry	Acre yield, bu.	Erect plants at harvest, %	Husk grade
La. 521	70.0	68	Good
Dixie 11	55.1	64	Fair
Funk's G-791W	54.5	67	Good
Funk's G-737	54.0	70	Good
Dixie 18	54.0	75	Good
Calhoun Red Cob	27.3	22	Good

A difference of 5.4 bushels per acre between any two entries is required for significance.

Adaptability of Various Corn Hybrids to Mechanical Harvesting

Tests in 1951 were subject to winds of high velocity just prior to harvest that caused severe lodging. Tables 17 and 18 clearly show that harvesting by mechanical means under these conditions leaves considerable corn in the field. For most years it will prove profitable to glean mechanically harvested fields with cattle or hogs. (A steer should be at least two years old to cow-down corn.) Electric fencing has proved to be especially adaptable for this purpose.

A moisture content of about 20 per cent has been found most desirable for mechanical harvesting when a drier is not available. R. Y. Ratcliff at St. Joseph lists the following reasons for harvesting corn with 20 per cent moisture in the grain: (1) If the corn is going to stand up, it will be standing at or above this moisture content; (2) the stalks are green enough not to snap off —they pull through the machine; (3) corn at 20 per cent moisture does not shell while being harvested as badly as drier corn; (4) equipment damage is less and harvesting faster, for there is less clogging and choking up of the picker.

J. Y. Oakes and L. L. McCormick at Bossier City presented data, Table 17, that show a close relationship between per cent erect plants and the per cent corn recovered mechanically.

Coker's Coastal 811, a white corn, had the largest number of bushels per acre harvested mechanically in each test, whereas NC 27 and Dixie 18 were the leading yellow hybrids.

There are only one year's data available giving results of mechanically harvested tests. These hybrids all mature at practically the same time. The differences in moisture content were not considered in computing yields; however, the moisture contents were apparently very similar.

Table 17—Corn hybrid test on Yahola very fine sandy loam harvested with a mechanical picker, Bossier City, 1951.

Entry	Acre yield, bu.	Acre yield harvested mechanically, bu.	Yield harvested mechanically, %	Erect plants, %	Ear height, in.
Dixie 11	90.1	55.9	62	43	55
La. 521	80.5	53.5	67	62	61
La. 468	79.7	57.1	72	55	55
Dixie 18	79.3	62.2	78	73	63
N.C. 27	79.0	65.8	83	79	55
Funk's G-721	76.2	60.3	79	64	46
Funk's G-714A	73.0	49.6	68	60	50
Coker's Coastal 811	72.4	66.3	92	90	49
Jarvis Prolific	56.7	39.9	70	64	42

Table 18—Corn hybrid test on Commerce very fine sandy loam harvested with a mechanical picker, St. Joseph, 1951.

Entry	Acre yield, bu.	Acre yield harvested mechanically, bu.	Yield harvested mechanically, %
La. 468	108.2	78.5	73
N.C. 27	106.3	67.5	64
Coker's Coastal 811	103.2	85.7	83
Dixie 18	99.1	67.3	68
Funk's G-737	96.6	44.8	46
Funk's G-714A	96.0	41.3	43
Jarvis Prolific	86.0	57.8	67

HYBRID RECOMMENDATIONS, 1951

North Louisiana:

- Dixie 11 (white)
- La. 468 (white)
- Funk's G-780W (white)
- Coker's Coastal 811 (white)
- Dixie 18 (yellow)
- *N.C. 27 (yellow)
- *Dixie 22 (yellow)
- Funk's G-714A (yellow)

South Louisiana:

- La. 521 (white)
- Dixie 18 (yellow)
- Funk's G-737 (yellow)

Dixie 18 is recommended for silage throughout the state.

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*These hybrids have good yielding ability but they should be harvested early, as their husk protection is not ample.

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Louisiana Bulletin No. 462 February, 1952

Anhydrous Ammonia Equipment

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BY
HARROLD T. BARR

LOUISIANA STATE UNIVERSITY
AND
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AGRICULTURAL EXPERIMENT STATION
W. G. TAGGART, DIRECTOR

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ANHYDROUS AMMONIA EQUIPMENT

Harold T. Barr[1]

The supply of nitrogen for farm crops formerly was obtained by turning under green nitrogen fixation crops, animal manure or from the importation of Chilean nitrate and Peruvian guano. The importation of the latter two into the United States began about 1830. Ammonia production in the United States prior to 1920 was largely as a recovery from coke oven gases. The accelerated demand for ammonia in World War I was responsible for an attempt to manufacture ammonia synthetically at Muscle Shoals, Alabama. Shortly after the close of World War I this was given up as uneconomical. In the early 1930's there was an agitation to use anhydrous ammonia or aqua ammonia as a fertilizer; but the commercial fertilizer mixers and other industries quickly absorbed all commercial production available and the direct application of anhydrous ammonia as a nitrogen fertilizer was forgotten. The demands of World War II greatly accelerated the synthetic production of ammonia, with over twenty plants in the United States, and at the war's end the production capacity was well above normal industries' demand.

Anhydrous ammonia (NH_3) is supplied today as a by-product of the oil industry and by plants built specifically for producing ammonia. In plants at Sterlington and Lake Charles, Louisiana, natural gas, steam and air are processed at elevated temperatures to yield a gaseous mixture. After removal of the carbons from the gaseous mixtures the remaining parts of pure hydrogen and one part of pure nitrogen by volume are combined in the presence of a catalyst at high temperatures and pressure to form ammonia.

PROPERTIES OF ANHYDROUS AMMONIA

Anhydrous ammonia at normal temperatures and atmospheric pressure is a colorless alkaline gas, having a sharp penetrating odor. Liquid ammonia (NH_3) has a density of 42.57 pounds per cubic foot at -28° F., its boiling point. The vapor pressure increases rapidly with temperature: at 50° F. it is 74.5 psi (pounds per square inch); at 75° F. it is 125.8 psi; at 100° F. it is 197.2 psi; and at 125° F. it is 293.1 psi. Anhydrous ammonia (NH_3) weighs 5 pounds per gallon and contains 82 per cent nitrogen. Anhydrous ammonia may be diluted with water to form aqua ammonia containing up to 35 per cent ammonia by weight. Up to 30 per cent, this solution will produce little or no pressure. Anhydrous ammonia gas is inflammable when mixed in the proportions of 16 to 25 per cent by volume with air. Ammonia is corrosive to copper, copper alloys, aluminum alloys, and galvanized surfaces. Ammonia vapors will kill germinating seed and plant leaves on direct contact. Ammonia vapors cause irritation to the eyes, nose, throat and lungs. High concentrations of ammonia may burn, blind, strangle, or kill.

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Anhydrous ammonia is the cheapest form of nitrogen available today, as shown by Table I. These figures are based on local prices and may vary from one locale to another. The large user of anhydrous ammonia who owns his own carload storage is buying at approximtaely $95 per ton, while the smaller user contracting for his ammonia applied to the soil or buying it in 500-gallon quantities delivered to his farm, is paying in the neighborhood of $140 per ton.

TABLE I. Availability and Cost of Nitrogen in Nitrogenous Fertilizer

Type of Fertilizer	Per Cent Nitrogen	Price per Ton	Cost per Pound of Nitrogen
Anhydrous Ammonia	82	$ 95.00	.0579
" "	82	120.00	.0731
" "	82	140.00	.0853
Ammonium Nitrate	33	73.00	.1106
Cyanamid	20	60.00	.15
Sulphate Ammonia	20	60.00	.15
Nitrate of Soda	16	60.00	.1875

Anhydrous liquid ammonia is shipped in tank cars containing approximately 52,000 pounds of ammonia. The insulated tank cars are built and loaded in accordance with Interstate Commerce Commission regulations.

The unloading, storage and storage locations of anhydrous ammonia will vary from state to state. In general, the rules conform to the standards of the National Board of Fire Underwriters for Liquefied Petroleum Gases (Pamphlet #58) and the ASME code for Unfired Pressure Vessels. Detailed rules are established and enforced in Louisiana by the Anhydrous Ammonia Commission established by the State Legislature in 1948 and amendments of 1950 in Mississippi by th Liquefied Gas Division of the Motor Vehicle Comptrollers office as defined by the State Legislature in 1948; and in Arkansas by the State Boiler Inspector.

BULK STORAGE

Containers for anhydrous ammonia to comply with the Louisiana regulations shall be constructed and tested in accordance with the 1950 code of the Unfired Pressure Vessel Code of the American Society of Mechanical Engineers. Briefly, an above ground storage container, farm trailer or tractor tank shall have a working pressure of 250 psi and a refrigerated storage shall have a working pressure of 75 psi. No underground storage tank will be approved.

Above ground bulk storage tanks vary in size from the 1500-ton Horton-Sphere down to the 150-pound cylinder. The Horton-Sphere 1500-ton storage complete with compressors, piping, etc., will cost approximately $325,000. With this type storage the ammonia gas is removed in a continuous cycle, recompressed, cooled and returned to the storage. State and insurance regulations require that each single storage unit of over 30,000 gallons or storage unit designed for a working pressure of less than 200 psi must be provided with a refrigeration system to maintain the pressure below the pop-off pressure. In addition to a minimum of one electric automatically operated compressor and condensors there must be one or more gas or fuel operated engine compressors and condensors in stand-by condition for each of the above types of installation.

Perhaps the most popular type of storage is the single 30,000-gallon tank, costing from $9,000 to $10,000, or a battery of 6000-gallon tanks costing from $2,500 to $3,000 each, installed. The smaller tanks enable a dealer or plantation to add tanks as requirements grow. By proper arrangement of the smaller tanks and valves the dealer assumes less risk of losing large quantities of ammonia by defective pop-off valves, etc.

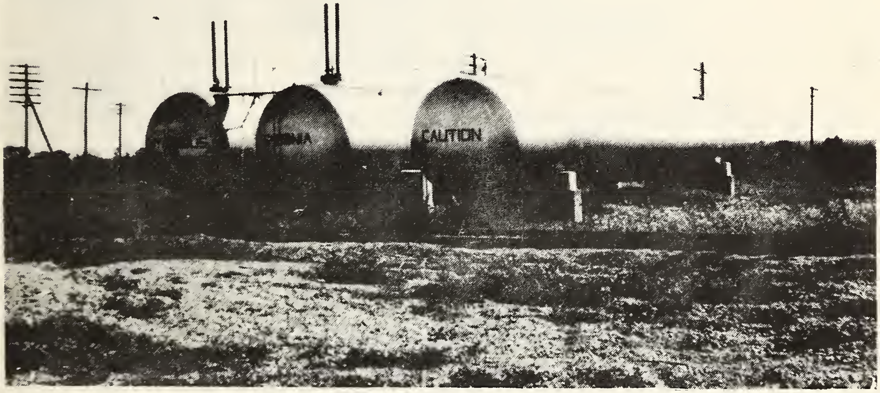

Figure 1. Installation of Three 30,000-Gallon Anhydrous Ammonia Storage Tanks.

In order to transfer the anhydrous ammonia from the railroad tank car to the storage tank, it is necessary to create a pressure differential between the two. In most installations this is accomplished by using a compressor. The suction side of compressor is connected to the vapor valve of the storage tank and the discharge side to the vapor valve of the tank car. A liquid ammonia line is connected between the liquid discharge valve of the car and the storage tank. This type of storage tank setup is shown by a diagram in Figure 2.

When the compressor is started, the pressure in the tank car will become sufficiently greater than that in the storage tank to cause the liquid ammonia to flow into the storage tank. During the unloading, the pressure differential between the car and the storage should be about

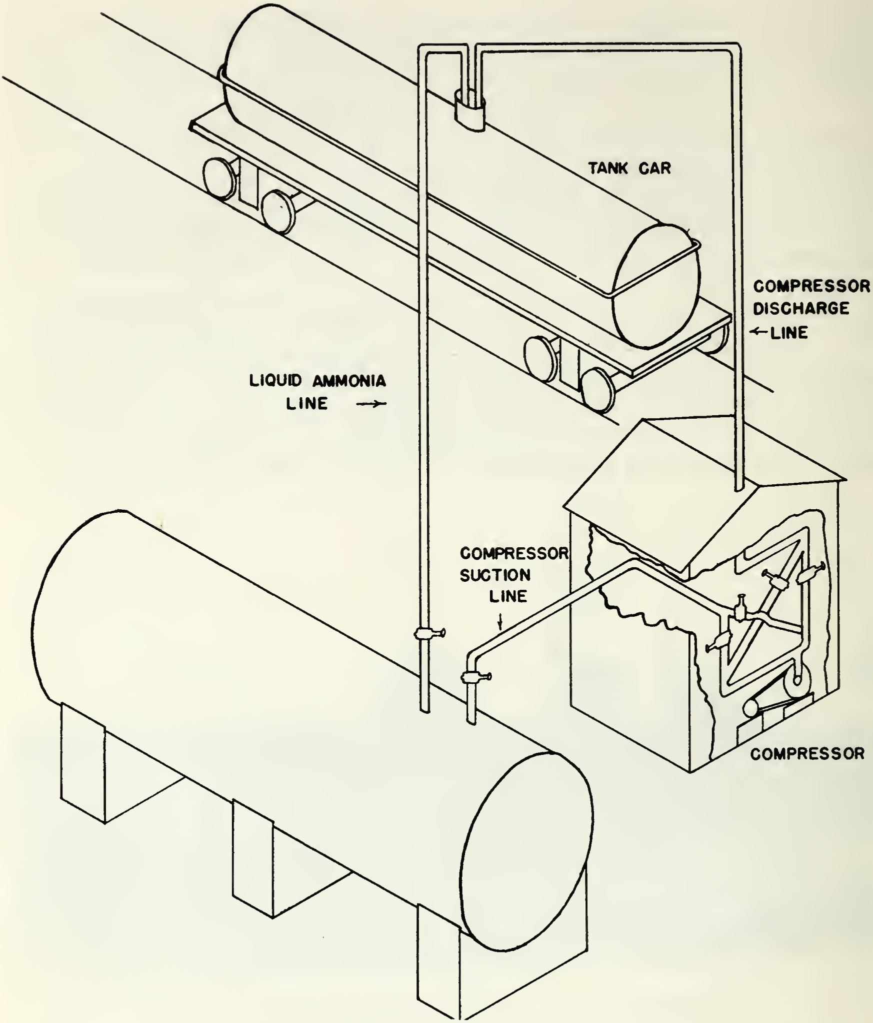

Figure 2. Diagram of Tank Car to Bulk Storage, Showing Unloading Connections.

50 psi. After all the liquid anhydrous ammonia has been transferred, the pressure will drop to about 10 psi and some ammonia gas will still remain in the tank car. By changing the valves the action of the compressor is reversed and the ammonia vapor in the tank car is reduced to about 5 psi, thus recovering all the ammonia vapors in the car. Test weighing of the car shows that it does not pay to operate too long in this reversed cycle as the pressure may be built up in the storage tank to such a point as to cause the safety valve to pop off, thus losing more than was gained by getting the very last gallon out of the car. In shipping anhydrous ammonia by railroad car, the car is weighed before being filled by

the manufacturer and again when the empty car is returned; the buyer is then billed for the difference. Several cars tested showed that when all liquid NH_3 had been removed, the ammonia vapor remaining accounted for 300 pounds per car. Five hours was required to pump down to zero pressure, which would not be economical when labor, power and wear on compressor cost were considered.

In unloading tank cars of anhydrous ammonia it has been recommended and found satisfactory by bulk dealers to reduce the car pressure to 55 psi in summer and 35 psi in winter. DO NOT reduce the tank car pressure below atmospheric pressure (zero gauge) or air will be drawn into the car. DO NOT use compressed air to force the ammonia from tank car to storage, as explosive mixtures may be formed. In filling a storage tank for the first time, bleed off the air from the top of the tank until white ammonia vapors appear, then close valve to air and start compressor. Wherever condensors, pumps and compressors are used, they should be manufactured by a reputable concern and recommended by the manufacturer for use with ammonia.

It is recommended that all storage plants handling ammonia have on hand as a minimum the following equipment:

1. Approved type gas mask with refill charges.
2. One pair of rubber gloves.
3. One pair of rubber boots.
4. One rubber slicker and/or rubber pants and jacket.
5. Easily accessible shower bath and/or one 50-gallon, open-top drum filled with water.
6. One pair tight fitting ventless type goggles.
7. First aid kit.
8. Fire extinguisher.

TRANSPORT EQUIPMENT

The transportation of anhydrous ammonia over the public highways must be in compliance with the rules and regulations prescribed by the respective states and the Interstate Commerce Commission as set forth in the Motor Carrier Safety Regulations Revised—Parts 1, 2, 3, 5, 6, and 7.

Tanks of 500-, 1000- and 3000-gallon capacity are used to transport anhydrous ammonia by mounting them on motor truck trailers, motor trucks and trailers. Tanks of over 1200-gallon capacity for farm trailer transports are prohibited by the Rules and Regulations of the Louisiana Anhydrous Ammonia Commission.

As shown in Figure 3, the valves should be protected by some form of a cover such as the one on rear of tank. The guard should be sufficiently strong to prevent damage to any of the gauges should the trailer turn over, be backed into some obstruction, or have material thrown against the tank. Brackets welded to the tank (by tank manufacturer) for attaching to trailer are better than bands. In order to pull this type

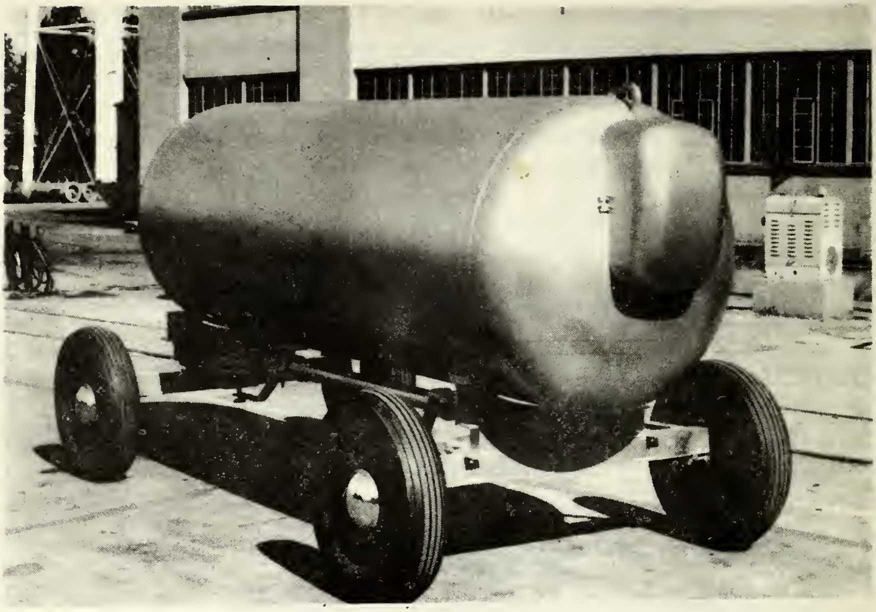

Figure 3. Farm Trailer and 1000-Gallon Anhydrous Ammonia Tank.

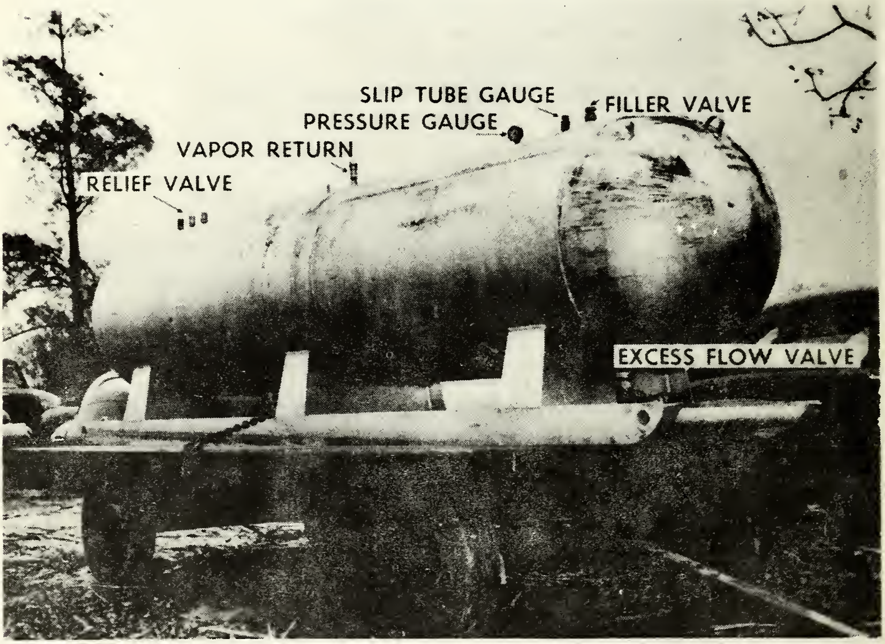

Figure 4. 3000-Gallon Skid Tank.

of trailer over the highways, most states require four-wheel brakes and the wording "ANHYDROUS AMMONIA" "CAUTION" in letters at least 6 inches high on each side and the rear of the tank. The trailer should be equipped with the required safety hitch, chains, lights, etc., as provided by law in the respective state.

Tank shown in Figure 4 is well mounted on its own foundation and can be easily moved from one location to another on the farm, but should not be used as a transport as there is no guard over the valves, it is loosely chained on the truck and the center of gravity is too high, making it turn over easily.

APPLICATION OF ANHYDROUS AMMONIA TO THE SOIL

Some of the earliest records of anhydrous ammonia being used as a source of nitrogen in the United States were found in some reports on Agriculture on the Pacific Coast. In this report the cylinders of anhydrous ammonia were placed on the irrigated ditchbank; the ammonia was released through tubes under the surface of the irrigation water, and the nitrogen thus distributed or applied by the irrigation water.

One of the manufacturers of regulators has recently introduced a valve that has successfully handled anhydrous ammonia for irrigation water. This valve has replaceable orifices and has been calibrated in three ranges so as to handle from 7 to 135 pounds of anhydrous ammonia per hour.

A machine for applying anhydrous ammonia to the soil was developed and patented by Floyd Dewitt in 1939. The patent on this horse-drawn machine was assigned to the Shell Development Company. Two later patents of the Shell Development Company cover a metering device and a method for covering the applicator with an ice coating to shield it from wear. Work was started in 1944 by the Mississippi Agricultural Experiment Station on the use of anhydrous ammonia as a source of nitrogen, and in 1947 a two-row machine for applying anhydrous ammonia was demonstrated to a large group of engineers and farmers. The Louisiana Agricultural Engineering Department at Louisiana State University started work in 1948 on applicator feet and anhydrous ammonia metering valves.

The machines in general use today for applying anhydrous ammonia are made up of a frame for mounting, a high pressure welded steel tank of about 110-gallon capacity, control valves, distribution and metering valves, distributing hose lines and soil shanks. The units for the most part are mounted on general purpose cultivating tractors of 2- or 4-row equipment.

The tanks are of welded steel constructed and tested in accordance with the code of the Unfired Pressure Vessel Code of the American Society of Mechanical Engineers; the 1950 code requires 250 psi working pressure for tractor containers. Butane tanks cannot be used as they do not have sufficient strength. Propane tanks have sufficient strength but

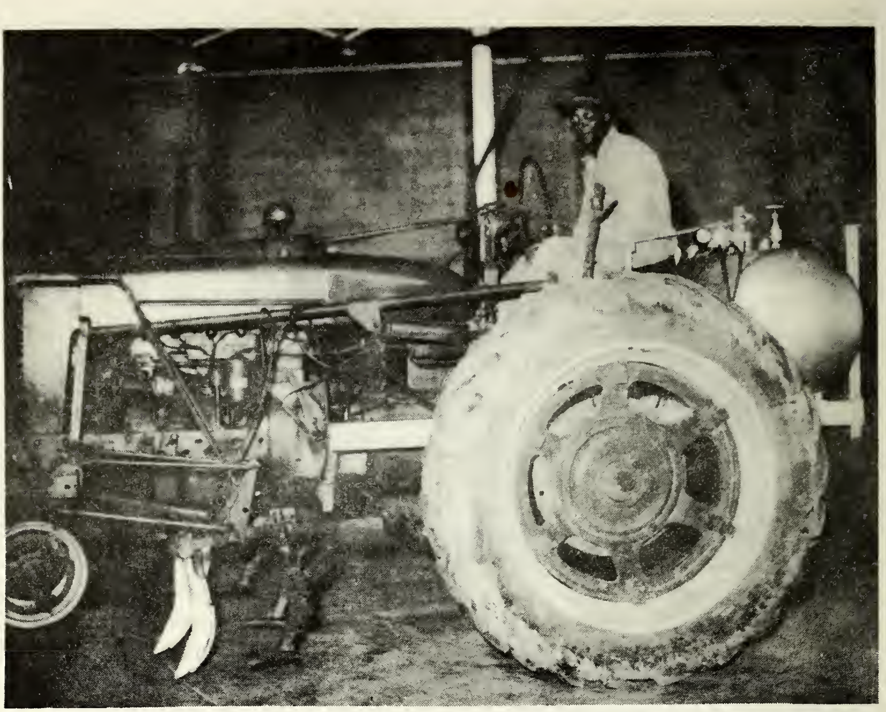

Figure 5. Two-row Anhydrous Ammonia Applicator. Applicators Set 20 inches Apart for Side-dressing of Cotton.

are almost universally fitted with brass or bronze valves which cannot be used with success or safety in the presence of ammonia. If propane tanks are refitted with steel valves and gauges for anhydrous ammonia it is recommended that they not be changed back to propane. Some state regulations (Louisiana as an example) prohibit alternate use of containers for propane and anhydrous ammonia. Brass or bronze in the presence of ammonia may develop internal checking that is not noticeable to the eyes. A blow or twist to a brass fitting on an ammonia container might cause the fitting to break off and release the ammonia, severely injuring the operator.

Tractor tanks are generally equipped with:

1. Liquid outlet valve, connected to a pipe extending down inside the tank to within ½" to ¾" of the bottom. A 1/64" mesh strainer is generally used on the bottom of this pipe. This valve should screw directly into the shell of the tank. Size ½". (Angle valve, Fig. 6.)
2. Pop-off relief valve or safety valve of ¾" or 1", set for 250 psi.
3. A ¾" or 1" automatic back seating inlet filler valve.
4. A 300-pound pressure gauge built especially for ammonia, with no brass screws or brass bourdon tube.
5. Liquid level gauge. The liquid level gauges are either the slip tube type or the float and dial indicator. The latter is handier as it shows

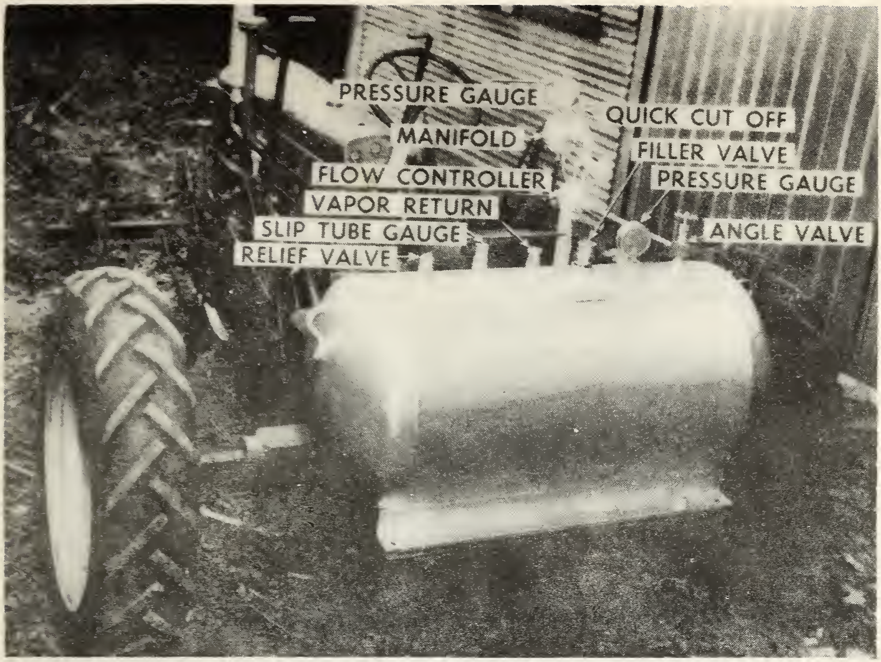

Figure 6. Anhydrous Ammonia Tank Mounted on Tractor, Showing Valves.

at a glance the amount of liquid in the tank. This type of gauge is becoming more popular and there is no danger of accidental irritation or burns such as could result if the slip tube is not operated correctly. However, this type is not normally guaranteed for over one season.

6. Vapor return valves, ½" or ¾". This type valve is used for filling when a pump or compressor is used or where the vapor is allowed to escape to the surrounding air by a special release device. In Louisiana it is permissible to bleed tanks to the open air only when the filling is done on the owner's property more than 100 feet from the highway or adjacent properties. All containers or tanks shall be equipped with an approved liquid level gauging device so that the maximum volume of container filled by liquid shall not exceed 85 per cent of its water capacity.

Metering Equipment

The metering of anhydrous ammonia presents a difficult situation in that the pressure in the tank will reduce some as the ammonia is removed, while on the other hand the rise in tank temperature between morning and mid-day will cause increased pressure. For the average user the metering device must withstand pressures of 150 to 250 psi on the high pressure side, 0 to 90 psi on the low pressure side, be built rugged, simple, not too heavy and capable of handling up to 500 pounds of anhydrous ammonia per hour. Meters for handling larger quantities are now under test and should be available during 1951-52.

Anhydrous ammonia must be metered either as a liquid or as a gas in order to secure a true measure. Passing the liquid anhydrous ammonia through unnecessary piping between tank and metering device may allow some expansion or heat transfer, and thus some liquid becomes a gas with a resulting erroneous measurement.

The simplest and cheapest metering device tested by Louisiana Agricultural Engineering is a needle valve and pressure gauge for controlling the flow of anhydrous ammonia into a manifold. With this control, if a uniform application is secured the pressure gauge on the manifold must be watched and the needle valve adjusted frequently to maintain the desired output.

Flow meters of several types that cause a known weight to be lifted predetermined heights, according to the amount of liquid passing through a calibrated tube, are in use for measuring output per unit of time. This valve is best for stationary installations and should be as close as possible to the ammonia container. If a small amount of the liquid ammonia vaporizes, the weight will oscillate to such a degree that it will be almost impossible to read. With the transparent gauge tube there is danger of breakage from some outside source or blowing up, if installed between a positive cut-off valve and the pressure tank. This type of valve should be installed with a positive shut-off valve on the tank and a cut-off valve beyond it that has a very small hole through it, allowing a small leak when cut off for turning around at the ends of rows. This leakage will also prevent undue pressure from expanding ammonia and breaking of the transparent gauge. A throttling valve should not be installed ahead of this type of meter as it may act as an expansion valve, causing some ammonia to vaporize and give an erroneous reading. In some systems, after the anhydrous ammonia is metered it is passed through a coil around the anhydrous ammonia supply line, which in turn will keep the ammonia cool and prevent expansion before being metered.

Metering may be by an automatic differential pressure regulator such as is used on liquified petroleum gas or air, but the valve must be especially designed and constructed of materials to withstand ammonia. Several such regulators are offered today, with some giving very accurate control. The best feature of this meter is that it can be set in the morning according to a chart furnished with the meter to give a predetermined amount of ammonia per hour and will not have to be reset during the day, regardless of tank pressure. Experimental checks have shown this type of valve to be accurate to within 1 per cent, if used within the capacity range of the valve.

A specially designed variable stroke, displacement pump (Figure 7) driven by a chain from the tractor axle has shown by test to give quite accurate metering results. The amount of nitrogen per acre is controlled by changing the stroke of the pump piston. This type of meter has the advantage that the speed of the tractor does not affect the amount

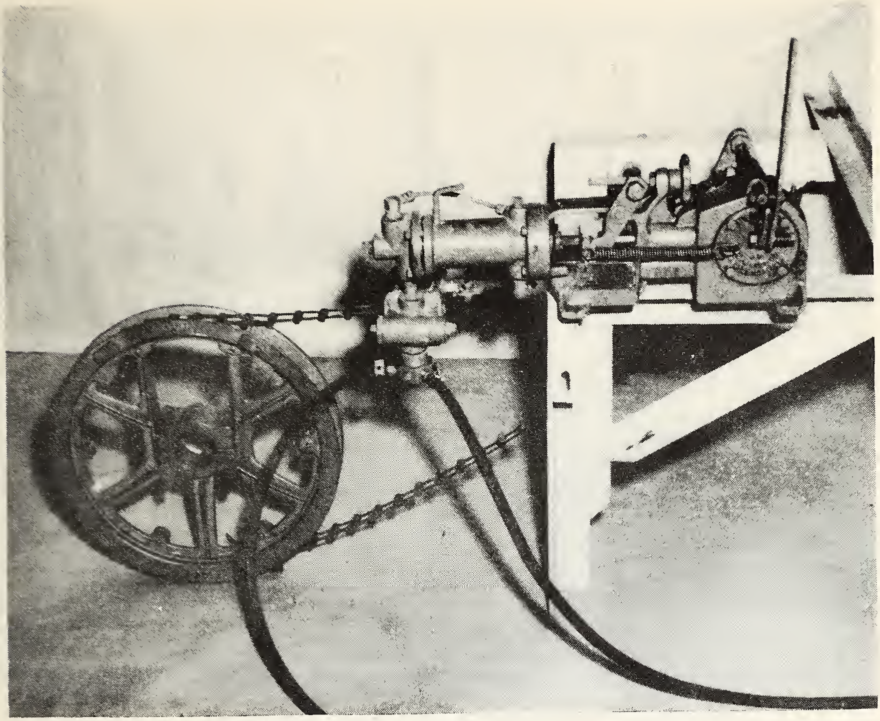

Figure 7. Variable Stroke Anhydrous Ammonia Pump.

of ammonia applied per acre, and the flow of ammonia is automatically stopped when the tractor stops. The pump is equipped with a heat exchanger to prevent the liquid ammonia from vaporizing. A small amount of wear or leaking valves will cause this unit to become inaccurate; hence it should be overhauled before the start of each season for maximum accuracy.

The best regulator may be woefully inaccurate unless it is calibrated with ammonia (not compressed air) and with the same size of hose and type of applicator foot that is to be used with the regulator in the field. Since the regulator manufacturer has no control over the type of applicator foot the farmer may use, some means of standardizing is necessary. Back pressure will materially affect the output of a regulator valve. Experimental tests by the Louisiana Agricultural Engineering Department have shown that in some cases the output was 19 per cent less than the indicated output. Some of the causes of back pressure were shown by tests to be restrictions in the hose line, such as 1/8 inch unions in a 1/4 inch hose, diameter and length of hose, or too small a hole in the applicator foot. A quick cut-off valve should be installed between the tank shut-off valve and the metering equipment. This valve should be of sufficient capacity so as not to act as an expansion valve and create an error in

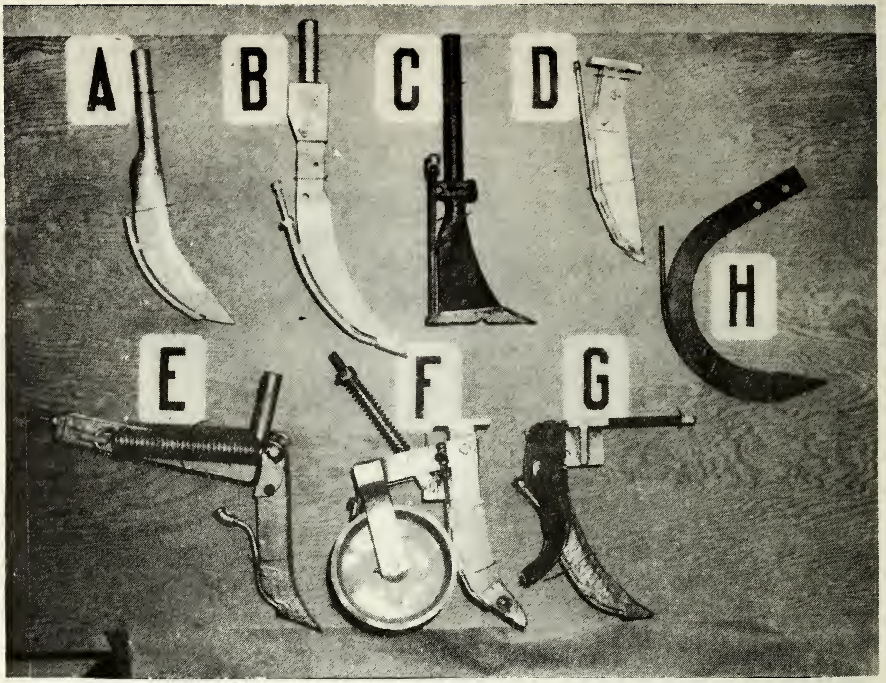

Figure 8. Anhydrous Ammonia Applicator Feet.

metering. The quick cut-off valve is used at the end of the field in turning around and allows meter to be left at the setting that has been determined as correct for the amount of nitrogen desired.

After passing through the metering equipment the anhydrous ammonia enters a manifold where it is divided to the hoses carrying the mixture of gas and liquid to the applicator shanks. The manifold must be compact, with the outlets or orifices to the various hoses of equal size and equally spaced around a cylindrical or spherical chamber. Manifolds made from pipe fittings failed to give equal distribution of anhydrous ammonia to the different applicator shanks.

Applicator Feet

The different applicator feet, applicator shanks, or applicator blade, on the market are all of somewhat similar design with a blade cross section area of approximately ½" x 3". Some are provided with a 1-⅜" round shank that will slip into the conventional round shank cultivator clamp, while others are clamped to spring cultivator shanks. Applicator feet for side-dressing row crops have proved equally satisfactory when made of one piece of drop forged or cast steel (A, Figure 8), or so constructed that a small bolt is sheared (B, C, & D, Figure 8) if a solid obstruction is encountered. Of some 500 sold in Louisiana similar to A, Figure 8, only 4 have been broken in three years and each of these by hooking into an old stump on the headland. This cast applicator has proved very resistant to wear in sandy soils. Where sandy soil is encountered the cutting edge and point of steel applicators should be hard surfaced as shown on G, Figure 8. Applicator feet (E, F & G, Figure 8) are being used on machines for applying anhydrous ammonia in pastures. The design shown as E in 8 is especially recommended where there is a likelihood of encountering a good many solid roots. The springs prevent breakage and quickly reset the foot. This foot has been used to a limited extent with cultivators in side-dressing but adds considerable weight. It is expensive and it is doubtful whether there are sufficient advantages to justify its use with a cultivator in side-dressing. The foot shown as F in Figure 8 is equipped with a roller, and G with covering slides. These are especially useful in sod lands for closing the applicator cut. It is also claimed that the roller will pull off roots and grass that accumulate on the applicator foot.

Some of the applicator feet are drilled or have pipes welded to the back edge of the applicator blade so as to feed the anhydrous ammonia down to the bottom of the cut made by the applicator. The applicator shown at A in Figure 8 extends the rubber hose down through a pipe on the back of the applicator to a point about one inch above and behind the point. There have been several claims that the anhydrous ammonia vapor should be insulated from the metal of the applicator blade so as to prevent chilling and icing over of the metal from the moisture in the soil. One patent claims the icing over of the metal will aid in reducing wear. Three years' experience at the Louisiana Agricultural Experiment Station with different types of applicator blades has not given any trouble from icing over.

The applicator should be as narrow as possible, have sufficient strength to prevent breakage or be equipped with a simple trip, be hard surfaced to prevent undue wear, provide for easy and secure attachment of anhydrous ammonia hose, and the final hole in the applicator should be constructed so as to deliver the ammonia without creating back pressure or without being plugged up easily by soil.

The applicator blade should normally be operated so as to release the anhydrous ammonia about 5 to 6 inches below the surface of the soil. In cultivated land it is recommended that a cultivator shovel or disk hiller be set at about half the depth of the applicator blades; dirt is thus crowded against the blade to completely seal in the ammonia.

When applying anhydrous ammonia in sod land, a wheel or slide such as shown at F and G in Figure 8 will close the applicator cut and seal in the anhydrous ammonia. In some cases the soil closes readily on the applicator blade and the ammonia combines with the clay particles and moisture so rapidly that no closure of the applicator cut is required. When anhydrous ammonia is escaping, a white vapor is seen rising back of the applicator or from the cut in the soil.

Back pressure which may reduce the actual output as much as 19 per cent is caused more by design and size of opening in applicator blade than by type of soil and moisture content, as shown by Tables 2 and 3, which represent an average of several tests run on two soil types at Baton Rouge.

TABLE 2. Back Pressure Under Varying Conditions

Orifice Pressure	¼"Hose-No Applicator Foot	Applicator A (In Air)	6" Deep in Sharkey Clay		6" Deep in Sandy Loam	
			7% Moisture	27% Moisture	5.2% Moisture	22.5% Moisture
10	0	3	3.5	5.0	3.5	5.0
20	0	6	7.0	7.0	7.5	7.0
30	0	9	10.0	10.0	10.0	10.0
40	0	12	15.5	14.0	13.5	14.0
50	0	16	18.0	18.0	18.0	18.0
60	0	20	22.5	24.0	24.0	24.0

TABLE 3. Back Pressure of Five Different Applicator Blades

Orifice Pressure	One ¼" Hole*	One ⅛" Hole**	One 3/16" Hole	One ⅛" Hole	Two 3/16" Hole
10	.75	4	5	3	2
20	1.5	7.5	8	6	3
30	1.5	11	11	9	4
40	2	18	15	12	5.25
50	2.5	22	21	16	6.25
60	2.5	27.5	27	20	7

*Hole in bottom end of applicator blade.
**One-eighth inch union in one-fourth inch hose at top of applicator blade.

Manufacturers of metering devices can furnish charts showing the correct setting of their valves. However, it is well to check or recalibrate each installation to be sure the desired pounds of nitrogen per acre are applied. With the applicator blades set to their correct depth, covering devices adjusted to seal in the ammonia, throttle set, and gear selected, make two or three trial runs over a measured distance of 200 to 300 feet. Divide the distance by the average number of seconds to get the feet traveled per second. A formula for calculating the pounds of ammonia per hour is as follows:

$$\frac{\text{Ft. per second x seconds per hr. x number of rows x distance between rows x lbs. of N/Acre}}{\text{Square feet per acre x 0.82}}$$

As an example, 60 pounds of nitrogen per acre is to be applied with a 4-row machine (one applicator for each 42" row spacing). A trial run gave a travel of 300 feet in one minute, or 5 feet in one second.

$$\text{Ammonia per hr.} = \frac{5 \times 3600 \times 4 \times 3'6'' \times 60}{43560 \times 0.82} = 493.8 \text{ lbs.} \div 5 = 98.76 \text{ gallons}$$

The above calculation gives pounds or gallons of anhydrous ammonia per hour. Some charts read in anhydrous ammonia per hour while others read in pounds of nitrogen per acre, with the tractor speed and gauge setting determining these amounts. As some manifolds can be changed to from 1 to 8 outlets and the size of each of these outlets varied, a multiple of tables are required to cover all installations. (See appendix.) These outlets (orifices) are regularly available from 3/32" to 11/64". The number of applicator feet or the placing of nitrogen is controlled by the requirements of the crop. The speed at which the tractor operates best is easily determined. The pounds of nitrogen per acre required is known; then from the orifice charts, select the proper size orifice outlets and pressure at which to set the control.

COST

Before one converts to anhydrous ammonia it is well to decide whether it would be cheaper to own his own storage, buy in 1000-gallon lots, or hire a commercial applicator to furnish and put the anhydrous ammonia in the ground as required. In some instances, dealers have 1000-gallon trailer tanks and tractor applicators that can be leased. Before going into this type of business or leasing such equipment, check your state laws on highway requirements on brakes and license, and whether the equipment is covered by liability insurance.

It is very hard to give an average cost on storage and field equipment because of the wide variations found in a survey of anhydrous ammonia users. One owner of a 6000-gallon storage refilled it twice in one year, while another owner of a 30,000-gallon storage used a little less than one-half his storage capacity. In arriving at an average cost for field equipment, the user who did some commercial work in addition to his own farming and the commercial applier were not considered. In a survey of Louisiana farmers in 1951 the yearly use of 2-, 3-, and 4-row side-dressing equipment varied from 6 to 30 days per season, with the majority getting 10 days. A few cotton and corn growers are equipping their 3-row busters so as to apply half the anhydrous ammonia as the rows are formed. The 4-row cultivator side-dressing unit is the most popular and will cover, on an average, 52 acres in 10 hours of operation.

The field equipment cost and total cost involved in using anhydrous ammonia are best understood by referring to the following tables. Where anhydrous ammonia is applied on 200 acres, some equipment cost will be slightly higher per unit of nitrogen and would result in a price between 10 and 11 cents per pound.

Charges made by the commercial applier for putting anhydrous ammonia in the ground are generally based on a fixed fee per acre plus the price of the anhydrous ammonia. The price has varied little whether it was for row crops or meadow land. However, if the row crop application also cultivated the complete row as the fertilizer was put in, an additional charge was made. A varying scale depending upon the acreage in each field is in effect with several commercial applicators. The following is given as an example: $3.50 per acre for 1 to 24 acres; $3.25 for 25 to 49 acres; $3.00 for 50 to 150 acres; and $2.50 for 151 acres and up.

AVERAGE YEARLY COST INVOLVED IN OWNING SMALL PORTABLE STORAGE AND TRAILER TANKS

500-Gallon Tank — Average Cost[1] — $350.00

Depreciation[2] — $31.50
Interest[3] — 8.75
Maintenance[4] — 10.50

$50.75

Trailer for 3-Ton or 500-Gallon Tank[1] — $250.00

Depreciation[2] — $22.50
Interest[3] — 6.25
Maintenance[4] — 25.00

$53.75

Total yearly cost — $50.75 plus $53.75 = $104.50

1000-Gallon Tank — Average Cost[1] — $550.00

Depreciation[2] — $49.50
Interest[3] — 13.75
Maintenance[4] — 16.50

$79.75

Trailer for 5-Ton or 1000-Gallon Tank — Average Cost[1] — $300.00

Depreciation[2] — $27.00
Interest[3] — 7.50
Maintenance[4] — 30.00

$64.50

Total yearly cost — $79.75 plus $64.50 = $144.25

AVERAGE YEARLY COST INVOLVED IN OWNING BULK STORAGE TANKS

6,000-Gallon Tank — Average Cost[1] — $3000.00

Depreciation[2] — $270
Interest[3] — 75
Maintenance[4] — 90
Power and Labor for Handling Ammonia — 25

$460

30,000-Gallon Tank — Average Cost[1] — $10,000

Depreciation[2] — $900
Interest[3] — 250
Maintenance[4] — 300
Power and Labor for Handling Ammonia — 80

$1530

All Costs Based on 10-Year Useful Life.

[1] Average cost includes tanks on foundations equipped with pump or compressor, valves, and ready to receive and deliver ammonia.

[2] Depreciation figured at original cost less 10 per cent junk price at end of 10 years.

[3] Interest figured at 5 per cent of one-half original cost.

[4] Maintenance — Painting, valves, hose and pipe replacements at 3 per cent of original cost.

AVERAGE YEARLY COST INVOLVED IN USING FIELD EQUIPMENT

Four-Row Equipment — Average Cost — $350.00

Depreciation	— $31.50
Interest	— 8.13
Maintenance & Repairs	— 32.50
Tractor Power[5]	— 80.00
Labor[6]	— 50.00
	$202.13
Cost per acre[7]	— $ .39
Cost per pound of nitrogen[8]	— .007

[5] Louisiana Bulletin 417 and unpublished records of Agricultural Engineering Department. Tractor cost based on average of ten 10-hour days used in applying anhydrous ammonia per year.

[6] Based on 50c per hour.

[7] Average of 10 days per season and 52 acres per day.

[8] Average of 55 pounds of nitrogen per acre on 4,502 acres of cotton.

AVERAGE OF ALL COSTS INVOLVED IN STORAGE AND APPLYING ANHYDROUS AMMONIA ON 800 ACRES OF ROW CROPS

(Used 30 tons per season)

	Yearly
Storage and Handling	
6000-Gallon Storage Tank*	$ 460.00
Transport One 1000-Gallon Tank and Trailer	144.25
Truck for Pulling Trailer 150 miles at 10c	15.00
Application	
Two Four-Row Tractor Tanks and Equipment	404.26
Labor Involved in Mounting and Dismounting Tanks From Tractors	5.00
Labor Filling 1000-Gallon Tank from 6000 and Transferring to Tractor Tanks	27.00
Anhydrous Ammonia — 30 tons at $102.50	3075.00
TOTAL COST	$4130.51
Cost per acre fertilized with 61.5 pounds nitrogen	$5.16
Cost per pound of nitrogen applied	.0855

*Tank refilled twice per season.

For pasture land or where anhydrous ammonia is to be applied before seeding on crops such as oats, wheat and rice, there is a machine such as shown in Figure 9. The ammonia tank, metering valve, hose and applicator blades on many of these can be transferred to your row crops, thus reducing the total cost of installation. A rolling coulter mounted ahead of the rigid spring applicator shank will lessen the degree in which sod is torn up. Applicator blades shown as E, F, G and H, Figure 8, are in use with pasture machines. The roller with F and the spring loaded slides at G each aid in pressing down the sod and sealing in the ammonia.

A direct connected machine shown as Figure 10 (rear and side

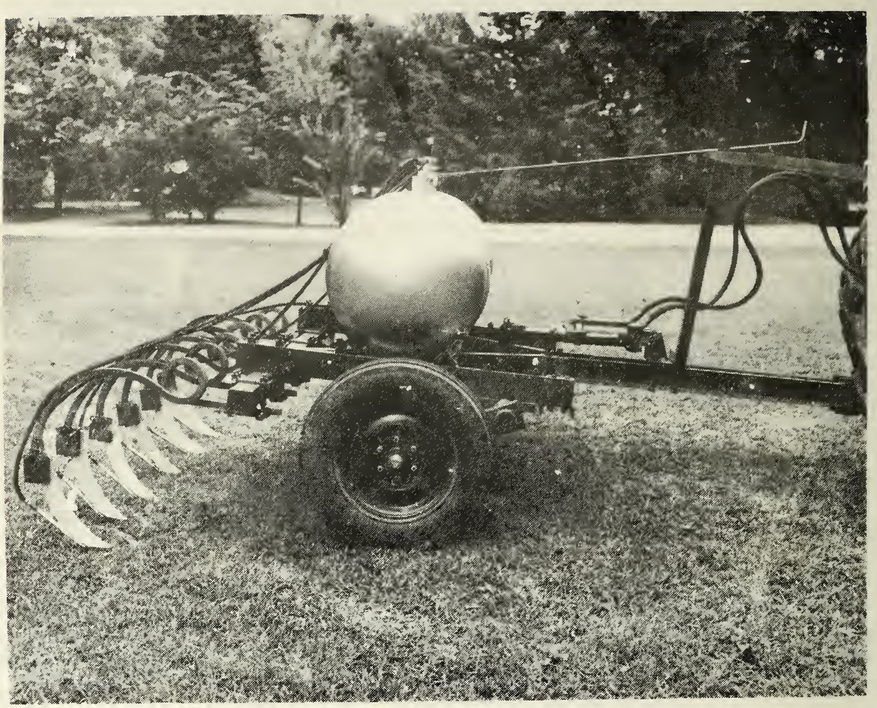

Figure 9. Pasture Anhydrous Ammonia Applicator.

view of L.S.U. machine) was developed for applying ammonia in tung orchards and has also been utilized for applying ammonia and building up rows for truck crops. When used to build up truck crop rows an additional disk is mounted on each side, when higher rows are desired. The rolling coulter in front serves a double duty: it cuts small roots and prevents them from hanging up on the applicator blade and it will also lift the unit over roots too tough to cut. The field type trailing applicator such as shown in Figure 9 can be used for orchard work by removing all but two applicator blades.

In applying anhydrous ammonia in sugar cane the ammonia tank is mounted either in front of the tractor radiator (Figure 11) or on the side (Figure 12), as the rear-mounted sugar cane cultivator prevents the usual mounting. In either case it is more convenient and advisable to place the quick cut-off valve and regulator where it can be easily reached by the tractor operator as shown at A - Figure 11 and Figure 12.

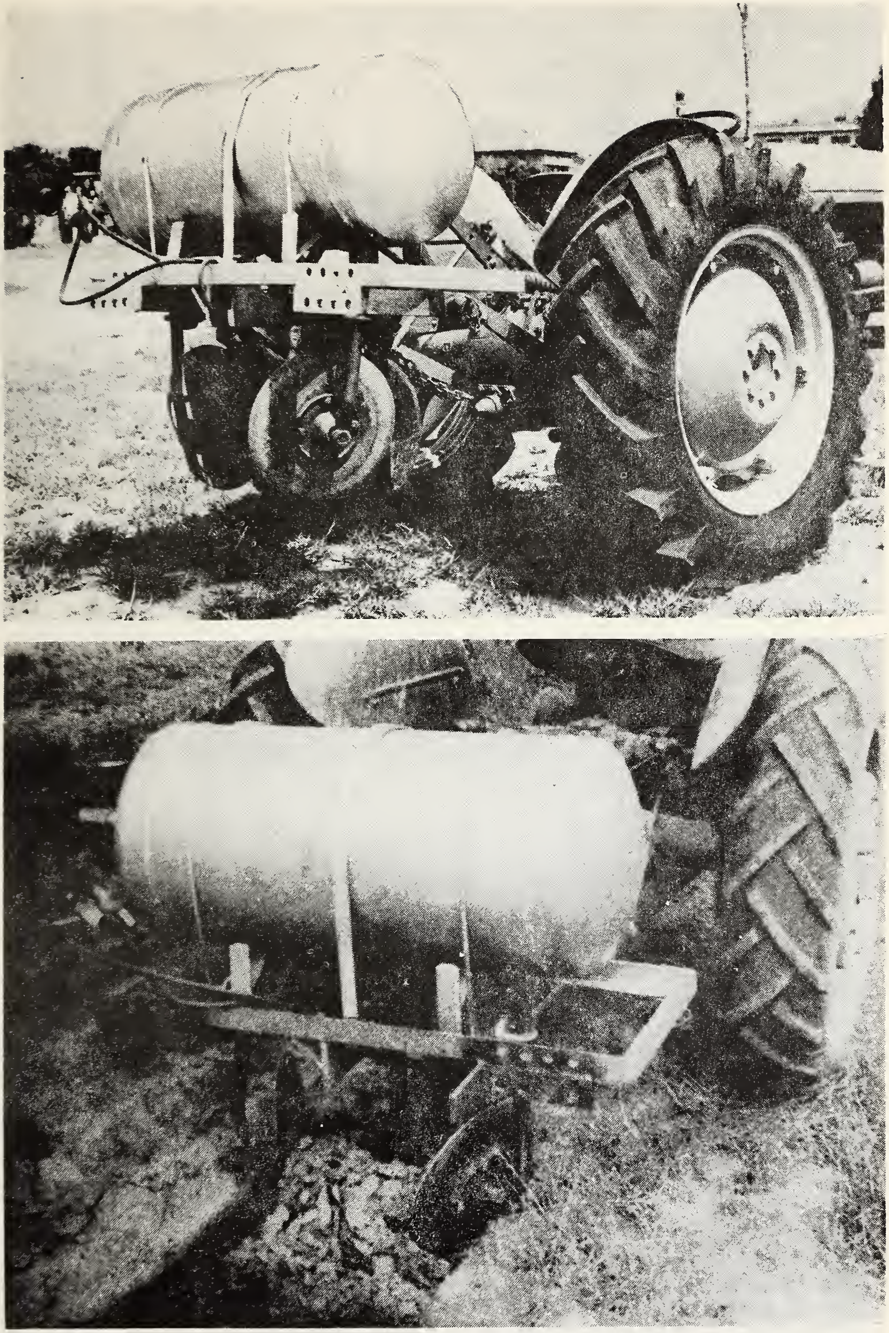

Figure 10. Anhydrous Ammonia Machine Developed at the Louisiana Agricultural Experiment Station.

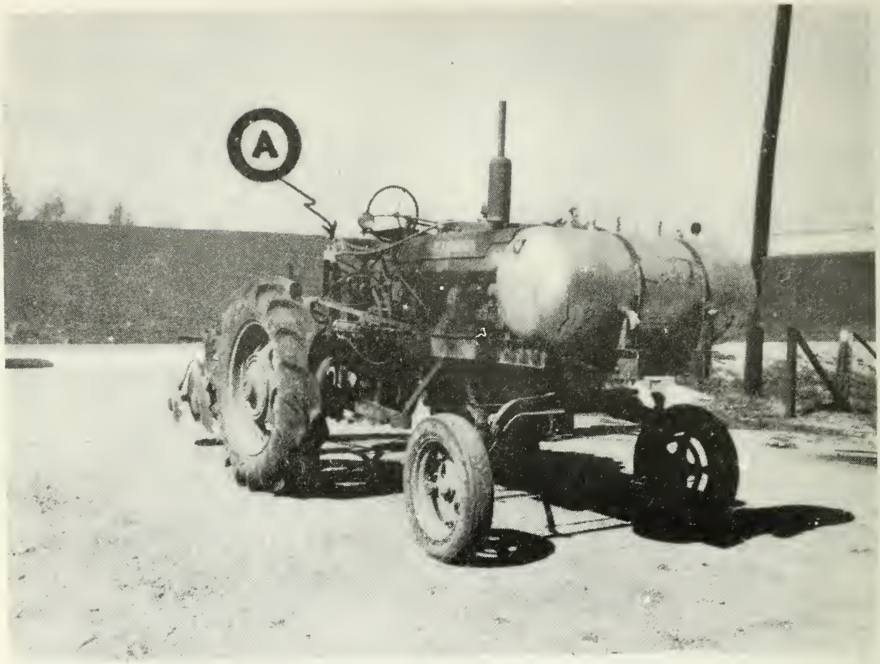

Figure 11. Front Mounting of Anhydrous Ammonia Tank.

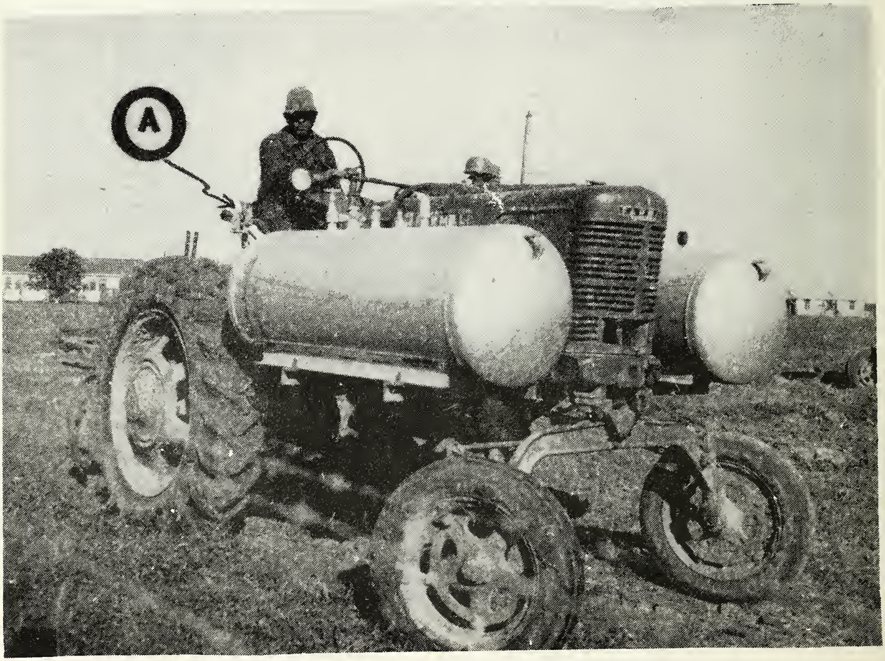

Figure 12. Side Mounting of Anhydrous Ammonia Tank.

SUGGESTIONS

Anhydrous ammonia can be very disagreeable, causing irritation, burns, or even death; but is not nearly so dangerous as ammonium nitrate. Be careful with both. Rather large quantities of anhydrous ammonia have been handled in the past three years by men with little or no previous knowledge in handling such materials.

Have your metering device, automatic gauge, or ammonia pump checked, and valves pump packing or diaphragm replaced if necessary before starting the season. Several manufacturers have a standard nominal fee for such service.

Keep a small amount of ammonia in your trailer tank and field applicator tank from one season to the next. DON'T LEAVE THE VALVES OPEN TO THE OUTSIDE AIR OR FILL TANK WITH WATER OR ANY MATERIAL OTHER THAN ANHYDROUS AMMONIA.

Don't use the ammonia tank for propane, nor the propane tank for ammonia.

Use only fittings, valves, and gauges that are manufactured for ammonia. Use NO BRASS OR BRONZE with ammonia; use only extra heavy steel fittings.

Be sure you have the correct chart for the number and size of orifices in your machine. Check for corrosion or rust in orifice opening before starting. After two years average use have your orifices checked for size of opening (they may be larger than you think). Check your hoses yearly. A blister on the outside of a high pressure hose is an indication the inside of your hose is breaking down. Better replace it.

If ammonia resistant hose was not used on the low pressure side it may look good on the outside and be alright inside; yet again the inside may be scaling off and will clog up your applicator blade hole.

Use the same size and length of hose to each applicator foot. Use all applicator feet of the same make on each machine, with final delivery holes for ammonia of similar size.

Be sure that your ammonia tank has been made by a well-established manufacturer who makes tanks for anhydrous ammonia in accordance with the code authorized by the Anhydrous Ammonia Commission of Louisiana and that the tank carries a permanently affixed plate showing the manufacturers name, "the code" under which the tank was manufactured, working pressure, capacity, thickness of material and other required data.

If your tank shows signs of leaking **DON'T attempt to calk it with a hammer and chisel, or weld it. Return the tank to the dealer or manufacturer from whom you bought the tank, for repairs and testing.**

If mounting lugs are wanted on the tank, buy one so equipped from the dealer. DON'T WELD ON THE TANK.

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10. Standards for the Storage and Handling of Anhydrous Ammonia and Ammonia Solutions, Anhydrous Ammonia Committee, Compressed Gas Association, Inc. Amended—2-24-50.

APPENDIX

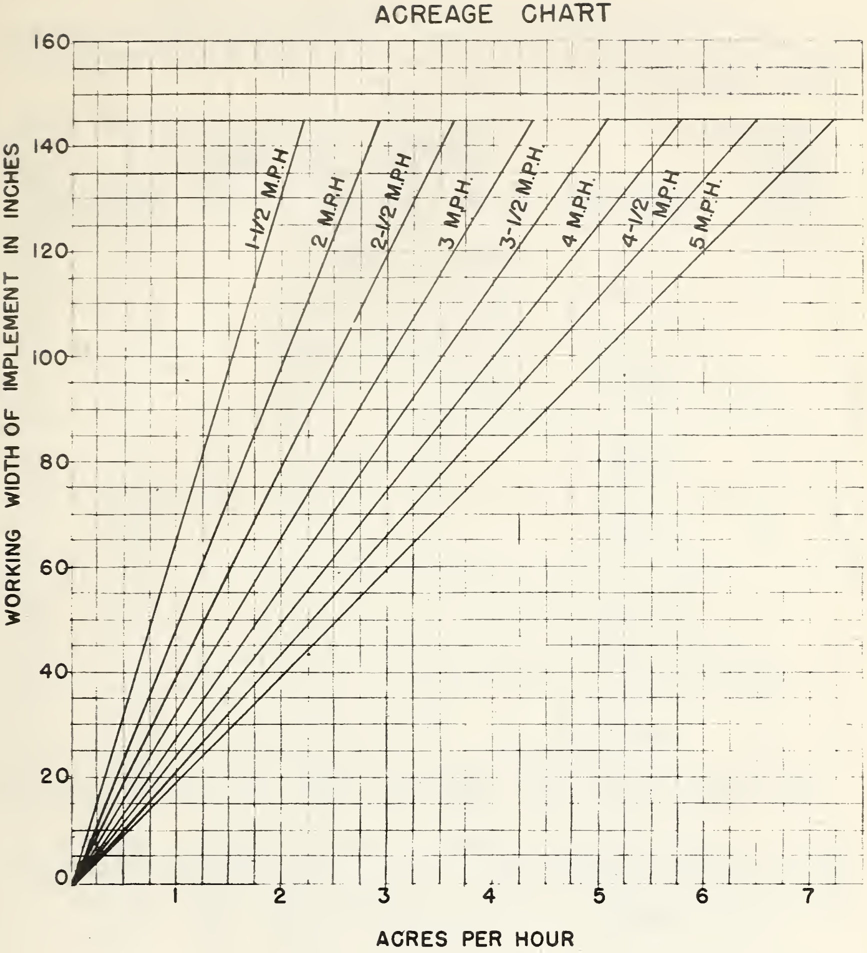
Originally all anhydrous ammonia equipment was sold with 3/32" orifice openings. Today some pieces of equipment are sold with fixed size orifices in the distribution chamber while other distribution chambers are tapped for ¼" or ⅜" pipe threads and interchangeable orifices of different sizes may be used, depending upon the quantity of anhydrous ammonia to be applied. Orifices are generally available in sizes ranging from 5/64" to 3/16" by 64ths.

In order to furnish a guide that will enable the farmer to set his anhydrous ammonia applicator without going through a series of formulae, the following sets of charts are given. These charts were prepared by calibrating valves with anhydrous ammonia using 21 feet of ¼" applicator hose, discharging the anhydrous ammonia under 2½ feet of water. The following charts are based on tank pressures of 130 pounds per square inch. When setting control valve, add 1 pound to that figure shown on chart for every 10 pounds that the tank gauge reads above 130 pounds per square inch, and likewise subtract 1 pound from the figure shown on chart for every 10 pounds that the tank pressure gauge reads below 130 pounds per square inch. Before using these charts for applying the season's anhydrous ammonia requirements, measure accurately a 1 or 2-acre plot, set your equipment for the desired amount of anhydrous ammonia and weigh the amount applied to this area. If the amount applied was not correct, check your tractor speed by one of the tables on pages 26 and 27; also check the size of your ordifices and other equipment. In running some calibrations at Louisiana Agricultural Experiment Station on different types of valves and gauges several proved inaccurate below 20 pounds and above 65 pounds, but proved very accurate between 20 and 65 pounds gauge pressure. Hence, from the following charts choose the chart for the number of orifices you use and size of orifices to give the desired amount of anhydrous ammonia with the speeds at which you operate your tractor when operating within the range of 20 to 65 pounds. If the size orifice in your applicator is not correct, ask your dealer for the proper size.

TRACTOR SPEED IN MILES PER HOUR IN VARIOUS GEARS OPERATING ON GOVERNOR AT MAXIMUM LOAD

			GEAR					
	MAKE &	MODEL	1	2	3	4	5	6
1.	A.C.	W.D.	2.30	3.62	4.87	9.63		
2.		C	1.87	3.29	6.78			
3.	CASE	D.C.	2.22	3.44	4.91	10.17		
4.		S.C.	2.29	3.35	4.68	9.73		
5.		V.A.C.	2.06	2.96	3.93	8.42		
6.		*V.A.H.	2.7	3.6	4.7	9.8		
7.	Caterpillar	D-2	1.49	2.37	2.91	3.50	5.05	
8.	John Deere	A	2.10	2.98	4.06	5.47	7.42	12.95
9.		*AH	1.50	2.50	3.50	4.50	6.50	11.25
10.			1.33	2.27	3.22	4.28	5.48	9.97
11.		B	1.27	2.04	3.16	4.24	5.43	9.92
12.		G	2.07	3.22	4.36	6.28	8.65	12.39
13.	Ferguson		2.60	3.64	5.11	10.98		
14.	Ford		2.77	3.69	5.21	11.25		
15.	Farm All	C	2.05	3.53	4.74	10.08		
16.		H	2.20	3.22	3.89	4.94		
17.		M & MD	2.20	3.20	3.88	4.80		
18.		*MV & MDV	2.50	3.38	4.12	5.00	15.88	
19.	Massey-Harris	22 RT	2.05	3.23	4.39	12.87		
20.		30 RT	2.18	3.30	4.23	6.01	12.32	
21.		44 RT	2.09	3.45	4.71	6.25	13.59	
22.	M & M	U	2.17	3.21	3.90	5.76	13.85	
23.		Z	2.09	3.04	4.35	6.07	13.00	
24.	Oliver	66	2.25	3.09	4.14	5.50	6.53	11.42
25.		77	2.29	3.16	4.27	5.67	6.71	11.83
26.		88	2.51	3.33	4.55	6.00	7.47	13.09

* Advertised speeds--Special high clearance tractors not yet tested at Nebraska. Other speeds as found in Nebraska Tractor Tests.



TRACTOR SPEED DETERMINED BY FEET PER MINUTE

Feet per Min.	MPH	Feet per Min.	MPH	Feet per Min.	MPH	Feet per Min.	MPH
176	2.0	246	2.8	317	3.6	387	4.4
185	2.1	255	2.9	325	3.7	396	4.5
194	2.2	264	3.0	334	3.8	405	4.6
202	2.3	273	3.1	343	3.9	414	4.7
211	2.4	282	3.2	352	4.0	422	4.8
220	2.5	291	3.3	361	4.1	431	4.9
229	2.6	299	3.4	370	4.2	440	5.0
237	2.7	308	3.5	378	4.3		

APPLICATION OF ANHYDROUS AMMONIA IN ORCHARDS

Chart showing the pressure setting for the output orifices for various rates of application of anhydrous ammonia when using FOUR 9/64-inch orifices with the Continental L. P. Products Company's standard size regulating control valve.

TRACTOR SPEEDS

SPEED MILES PER HOUR	POUNDS OF NITROGEN FOR 100 FEET OF TRAVEL				
	2½ LBS.	5 LBS.	7½ LBS.	10 LBS.	12½ LBS.
1½		35½	56		
2		48			
2½	29	62½			
3	35½				
3½	42½				
4	49				
4½	56				
5	62½				

PRESSURE SETTING FOR THE C.L.P.P. CO. CONTROL VALVE

Chart calculated for tank pressure of 130 lbs./sq. in. When setting control value pressure, add 1 pound to that figure shown on chart for every 10 lbs. that tank gauge reads above 130 lbs./sq. in., and likewise subtract 1 pound from that figure shown on chart for every 10 lbs. that tank pressure gauge reads below 130 lbs./sq. in.

The following charts are based on tank pressures of 130 pounds per square inch. When setting control valve, add 1 pound to that figure shown on chart for every 10 pounds that the tank gauge reads above 130 pounds per square inch, and likewise subtract 1 pound from the figure shown on chart for every 10 pounds that the tank pressure gauge reads below 130 pounds per square inch.

CHART FOR TWO 5/64" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor	Width of Implement in Inches																											
Speed	36"							40"							42"							48"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5				16	18	19	21				14	17	21	24			14	16	19	22	25			15	19	22	26	30
2.0			17	19	22	26	30		14	17	21	25	30	34		14	18	23	27	32	36		17	22	26	30	33	38
2.5		18	21	25	30	34	39		19	23	29	34	39	43	14	20	25	30	35	40	44	17	22	27	32	40	46	52
3.0		21	28	32	36	42	47	17	24	30	36	41	47	52	18	26	31	37	43	49	55	22	28	33	43	49	53	61
3.5	19	26	35	37	44	50	55	21	29	36	42	49	55	60	24	31	37	45	51	57	63	26	34	43	51	56	64	69
4.0	22	30	38	44	50	56	62	26	34	41	49	56	62	67	28	36	45	51	58	64	70	31	41	49	56	65	72	
4.5	26	35	43	50	56	62	68	30	39	47	56	62	68		32	41	50	57	64	71		38	48	57	64	72		
5.0	30	39	48	55	62	68		34	44	54	60	67			36	46	55	62	70			41	52	62	70			

Tractor	Width of Implement in Inches																											
Speed	72"							80"							84"							96"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5	14	20	26	31	37	42	48	17	24	30	36	41	48	53	18	24	31	37	43	50	55	22	30	37	43	50	56	62
2.0	22	30	37	43	50	56	62	25	34	42	48	55	62	68	27	38	43	51	59	64	70	32	42	50	57	66	72	
2.5	30	38	46	54	61	67		34	43	53	61	68			38	46	55	63	70			41	52	63	70			
3.0	37	46	56	64	71			42	52	62	70				43	55	64	72				50	62	72	70			
3.5	44	54	65					48	61	70					51	63	72					58	64					
4.0	51	62	71					55	67						59	70						65						
4.5	56	67						62							64							72						
5.0	62							67																				

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR FOUR 5/64" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor Speed	Width of Implement in Inches																				
	48"							72"							80"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5							10				11	14	16	19			10	13	16	19	21
2.0					11	14	16		10	14	17	21	24	27		13	16	19	23	26	33
2.5			11	13	16	19	21	10	15	19	23	26	31	34	12	17	21	26	30	34	38
3.0		10	14	17	21	24	27	14	19	24	28	33	38	41	16	21	26	32	37	41	47
3.5	9	13	17	21	25	29	32	17	23	28	34	39	45	51	19	26	32	38	44	49	55
4.0	12	16	20	25	29	32	37	21	26	33	39	45	51	56	23	30	37	44	50	56	61
4.5	14	19	24	29	32	38	42	24	31	38	45	51	57	62	26	34	41	49	56	62	68
5.0	16	21	27	32	37	42	48	27	34	41	51	56	62	68	30	39	47	55	61	68	

Tractor Speed	Width of Implement in Inches																				
	84"							96"							144"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5			11	14	17	20	23		11	14	17	20	24	26	14	19	24	29	33	38	42
2.0	11	13	17	21	24	28	32	11	16	20	25	29	33	37	20	26	33	39	45	51	56
2.5	13	18	23	28	32	37	41	16	21	27	32	37	42	48	26	35	41	49	55	62	67
3.0	17	23	28	33	39	45	50	21	27	32	39	45	50	56	33	41	50	59	65	71	
3.5	20	27	33	40	46	52	57	24	32	39	46	53	58	64	39	49	58	66	73		
4.0	24	32	39	46	53	59	65	29	37	45	53	59	66	71	45	56	61	73			
4.5	28	37	45	52	59	65	71	32	41	51	59	66	72		51	62	70				
5.0	32	41	50	57	65	71		37	48	56	64	71			56	68					

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR SIX 5/64" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor Speed	Width of Implement in Inches																				
	72"							80"							84"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5						10	12					10	12	14					10	13	15
2.0				10	13	15	17			10	13	15	17	20			10	13	16	19	21
2.5			11	14	17	20	23		10	14	17	20	24	27		11	15	18	21	25	29
3.0		11	15	19	22	26	29	10	14	17	21	26	30	33	10	15	19	24	27	31	35
3.5	10	14	19	23	27	31	35	13	17	21	26	30	35	40	13	18	24	28	32	37	42
4.0	13	17	23	27	32	37	41	15	20	26	30	36	41	45	16	21	27	33	38	43	49
4.5	15	21	26	31	36	41	46	17	24	29	35	41	46	52	19	25	31	37	43	49	55
5.0	18	24	29	35	41	46	53	20	27	33	40	45	52	58	21	28	35	42	49	55	61

Tractor Speed	Width of Implement in Inches													
	96"							144"						
	Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5				10	13	15	18		11	15	19	22	26	30
2.0		10	13	16	19	22	26	13	17	22	27	32	36	41
2.5	10	14	18	21	26	30	34	17	23	29	35	40	46	52
3.0	13	18	22	27	31	36	41	22	29	36	43	49	56	62
3.5	16	21	27	32	38	43	49	26	35	43	51	59	66	72
4.0	19	26	31	38	44	50	56	32	41	50	59	67	73	
4.5	22	29	36	43	50	57	63	36	46	56	66	73		
5.0	26	34	41	49	56	63	69	41	52	62	72			

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR TWO 3/32" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor Speed	Width of Implement in Inches																											
	36"							40"							42"							48"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M.P.H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5				9	11	12	13			7	9	12	14	16			8	11	13	15	18		7	9	12	15	18	22
2.0			11	12	13	18	21		9	12	14	18	21	23		9	13	15	19	22	25	8	12	15	18	23	26	30
2.5		11	13	17	21	24	27	9	12	16	20	23	27	31	9	13	18	21	25	30	33	12	17	21	26	30	34	39
3.0	11	13	17	21	26	30	33	12	16	21	26	30	33	36	13	18	21	26	31	35	40	15	22	26	31	36	41	47
3.5	12	17	21	26	31	34	40	14	20	26	30	35	40	44	16	21	26	32	37	42	47	18	26	31	36	43	48	53
4.0	13	21	26	31	34	41	46	18	23	30	35	41	46	52	19	25	31	37	42	48	53	23	30	36	43	49	55	61
4.5	18	24	30	34	41	46	52	21	27	33	40	46	52	58	22	30	35	42	48	55	60	26	34	41	48	55	61	67
5.0	21	27	33	40	46	52	58	27	34	40	47	53	59	64	25	33	40	47	53	60	65	30	39	47	53	61	67	

Tractor Speed	Width of Implement in Inches																				
	72"							80"							84"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M.P.H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5	10	13	18	22	26	30	33	12	17	21	25	30	34	39	13	18	22	26	31	36	41
2.0	14	21	26	31	36	41	47	18	23	30	35	41	47	52	19	25	31	37	43	49	53
2.5	21	28	33	40	46	52	58	23	31	38	45	52	57	63	25	33	42	43	53	60	66
3.0	26	33	41	48	55	61	66	30	38	47	53	60	66	72	31	12	49	56	63	70	75
3.5	31	40	48	56	63	69	74	35	45	53	62	69	74		37	43	56	64	71		
4.0	36	46	55	63	70			41	52	60	69	75			43	53	63	71			
4.5	41	52	61	69				47	57	66	74				49	60	70				
5.0	47	58	66	74				52	63	72					53	66	75				

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR FOUR 3/32" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor Speed	Width of Implement in Inches																				
	48"							72"							80"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5														17						17	20
2.0											16	19	21	24				18	21	24	27
2.5						17	20			17	20	24	27	30		16	20	23	27	30	34
3.0				16	18	21	24		17	21	25	29	33	36		20	24	28	32	36	41
3.5			16	18	22	25	28	16	20	25	30	34	39	43	18	23	28	34	38	43	48
4.0			18	22	26	29	33	19	24	29	34	39	45	50	21	27	32	38	44	50	56
4.5		16	21	25	29	33	37	21	27	33	39	45	50	56	24	30	36	43	50	56	63
5.0		20	24	28	33	37	42	24	30	36	43	50	56	63	27	34	41	48	56	63	70

Tractor Speed	Width of Implement in Inches																				
	84"							96"							144"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5					16	18	21				16	19	21	24		17	21	25	29	33	37
2.0			16	19	22	25	28			19	22	26	29	32	19	24	29	34	40	45	50
2.5		17	21	25	28	31	36		20	25	28	32	37	42	24	30	37	43	50	56	63
3.0	16	21	25	29	34	39	43	19	24	29	35	40	45	50	29	37	44	52	60	67	75
3.5	19	25	29	33	40	46	51	22	28	35	40	46	52	59	34	43	52	62	71	80	
4.0	22	28	34	40	46	52	59	26	32	39	46	54	61	67	40	50	60	71			
4.5	25	31	39	46	52	60	66	29	37	45	52	61	68	77	45	56	67				
5.0	28	36	43	51	59	66	75	32	42	50	59	67	77		50	63	76				

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR TWO 1/8" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor Speed	Width of Implement in Inches																											
	36"							40"							42"							48"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5						10	11						11	12					10	11	13				10	11	13	15
2.0				10	12	13	15				11	13	15	17			10	12	14	16	18			11	14	16	19	22
2.5			11	13	15	17	19		10	12	15	17	19	22		10	13	15	18	21	23		13	15	18	21	24	27
3.0		11	13	16	18	21	24	10	12	15	18	21	24	27	10	13	16	19	22	25	28	11	15	19	22	25	29	32
3.5	10	13	16	19	22	25	28	11	15	18	21	25	28	31	12	16	19	23	27	30	33	14	18	22	26	30	34	37
4.0	12	15	18	22	26	29	33	13	17	21	25	28	32	36	14	18	22	27	30	34	38	16	21	25	30	35	39	43
4.5	13	17	21	25	29	32	36	15	19	24	28	32	36	41	16	21	25	30	34	38	43	19	24	29	34	39	44	48
5.0	15	19	24	28	32	36	41	17	22	27	31	36	41	45	18	23	28	33	38	43	47	22	27	32	37	43	48	53

Tractor Speed	Width of Implement in Inches																				
	72"							80"							84"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5		11	13	16	19	21	24		12	15	18	21	24	28		13	16	19	22	25	29
2.0	12	15	19	22	26	29	32	13	18	21	25	29	33	36	14	19	22	26	30	34	38
2.5	15	20	24	28	32	36	40	17	21	26	31	36	40	44	18	23	28	33	38	42	47
3.0	19	24	29	33	38	43	47	21	26	32	37	43	48	53	22	28	34	39	45	50	55
3.5	22	28	33	40	45	50	55	25	31	37	44	50	55	62	26	33	39	46	52	58	63
4.0	26	32	39	45	50	57	63	29	36	43	50	56	63	68	30	38	45	52	59	65	71
4.5	29	36	43	50	57	63	68	32	40	48	55	63	69		34	42	50	58	65	71	
5.0	32	40	47	55	63	68		36	44	53	62	68			38	47	56	63	71		

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR FOUR 1/8" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor Speed	Width of Implement in Inches																				
	48"							72"							80"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5																					
2.0																					10
2.5													10	14					10	14	17
3.0												12	16	19				12	15	20	23
3.5							12				13	17	21	25			12	16	20	24	28
4.0						13	16			13	17	22	26	30		10	15	20	25	29	33
4.5					13	16	19		10	16	21	26	30	33		14	20	24	29	34	38
5.0				12	16	19	23		14	19	25	30	33	38	10	17	23	28	33	38	42

Tractor Speed	Width of Implement in Inches																				
	84"							96"							144"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5																			13	16	19
2.0							11						13	16			13	17	22	26	29
2.5					11	15	19				11	15	19	23		14	19	25	29	34	38
3.0				13	17	21	25			13	17	23	25	29	12	19	25	31	36	40	45
3.5			13	18	22	26	30		11	17	22	27	31	35	17	25	31	37	42	47	52
4.0			17	22	26	31	35		15	22	27	32	36	40	22	29	36	42	48	53	58
4.5		15	21	26	31	36	40	13	19	25	31	36	41	45	26	34	40	47	53	59	64
5.0	11	19	25	30	35	40	44	16	23	29	35	40	45	50	29	38	45	52	58	64	70

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR SIX 1/8" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor Speed	Width of Implement in Inches																				
	72"							80"							84"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M.P.H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5																					
2.0														14							15
2.5						14	16					14	16	19					15	17	20
3.0					15	18	20				15	18	20	23				16	19	21	25
3.5				16	19	21	25			15	18	21	25	28			16	19	23	26	30
4.0			15	19	22	26	29		14	18	21	25	29	33		15	19	23	27	30	35
4.5		14	18	22	26	29	33		16	20	25	29	33	37		17	20	26	30	35	39
5.0		16	20	25	29	33	38	14	19	23	28	33	38	42	15	20	25	29	35	39	44

Tractor Speed	Width of Implement in Inches													
	96"							144"						
	Pounds N. per Acre							Pounds N. per Acre						
M.P.H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5												15	18	20
2.0					14	16	18				15	19	23	26	29
2.5				15	18	21	23			16	20	25	29	33	37
3.0			14	19	21	25	29	15	20	25	30	35	40	44
3.5		15	19	23	26	30	35	19	25	30	36	42	47	52
4.0	14	18	22	26	31	35	40	22	29	36	42	46	53	59
4.5	15	20	25	31	36	40	45	25	32	39	46	53	59	63
5.0	18	24	29	35	40	45	49	28	36	44	51	58	63	67

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR TWO 9/64" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor	Width of Implement in Inches																				
Speed	36"							40"							42"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5							16						16	18						16	19
2.0					17	19	20				16	19	20	22				17	19	21	22
2.5			16	19	20	22	25			17	20	22	25	27		16	18	20	23	25	28
3.0		16	19	22	24	26	28		17	20	23	26	29	31	15	18	21	24	27	30	33
3.5		19	21	24	27	30	33	16	20	23	26	30	33	35	17	20	24	28	31	34	37
4.0	17	20	24	27	30	34	37	18	22	26	30	33	37	40	19	23	27	31	34	39	42
4.5	19	22	26	30	34	37	41	20	25	29	33	37	41	45	21	25	30	34	39	43	48
5.0	20	25	29	33	37	41	45	22	27	32	36	40	45	50	23	28	33	38	43	48	52

Tractor	Width of Implement in Inches																				
Speed	48"							72"							80"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5					17	19	20		16	19	21	24	26	29		17	20	23	26	29	31
2.0			17	19	21	24	26	17	20	24	27	30	34	37	18	22	26	30	34	37	41
2.5		17	20	23	26	29	32	20	24	28	33	37	41	45	22	26	31	36	40	45	50
3.0	17	20	24	27	30	34	37	23	28	34	38	43	48	53	25	31	37	42	48	52	58
3.5	19	23	27	31	35	39	43	27	33	39	44	50	55	61	30	36	42	49	55	61	67
4.0	21	26	30	35	40	44	48	30	37	44	50	57	63	68	34	40	48	55	62	68	74
4.5	24	29	34	39	44	48	53	34	41	48	55	63	69	75	37	45	53	61	68	74	
5.0	26	31	37	43	48	53	59	37	45	53	61	68	75		41	50	59	67	74		

Tractor	Width of Implement in Inches																				
Speed	84"							96"							144"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5		18	21	24	27	30	33	17	20	24	27	30	34	37	24	29	34	39	44	49	53
2.0	19	23	27	31	35	39	43	22	26	30	35	40	44	48	30	37	44	50	57	63	68
2.5	23	28	33	38	43	47	52	25	31	37	42	48	53	59	37	45	53	61	68		
3.0	27	33	39	44	50	55	61	30	37	44	50	56	62	68	43	53	62	71			
3.5	31	38	45	51	57	64	69	34	42	50	56	64	71		50	61	71				
4.0	34	43	50	57	65	71		39	48	57	65	71			57	68					
4.5	39	47	56	63	71			44	53	63	71				63						
5.0	43	52	61	69				48	59	68					68						

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR FOUR 9/64" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor	Width of Implement in Inches																				
Speed	36"							40"							42"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M.P.H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5																					
2.0																					
2.5																					
3.0														16						15	17
3.5						15	17					15	17	18					16	18	19
4.0					15	17	19				15	17	19	21				16	18	20	22
4.5				15	17	19	21				17	19	21	23			15	17	19	22	24
5.0				16	19	21	23			16	18	20	23	25			16	19	22	24	26

Tractor	Width of Implement in Inches																				
Speed	48"							72"							80"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M.P.H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5																					16
2.0												15	17	19				15	17	19	21
2.5							15				16	18	20	23			15	18	20	23	25
3.0					15	17	19			16	19	22	24	26		15	18	21	24	27	29
3.5				15	17	20	22		16	19	22	25	28	31	15	18	21	24	28	31	35
4.0			15	17	20	22	24	15	18	22	25	29	32	35	17	20	24	28	32	35	38
4.5			17	20	22	24	27	17	21	24	28	32	35	39	18	23	27	31	35	38	44
5.0		15	18	21	24	27	30	19	23	27	31	35	39	43	21	25	30	35	38	44	48

Tractor	Width of Implement in Inches																				
Speed	84"							96"							144"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M.P.H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5						15	17					15	17	19			17	19	22	24	27
2.0				15	17	19	21			15	17	20	22	24	15	18	22	25	28	32	35
2.5			16	19	21	24	26		16	19	21	24	27	30	18	23	26	31	35	39	43
3.0		16	19	23	25	28	31	15	19	22	25	29	32	35	22	26	32	36	42	46	51
3.5	15	19	23	26	29	33	36	17	21	25	29	33	37	41	25	31	36	42	48	53	59
4.0	17	21	25	29	33	37	40	20	24	29	33	37	42	46	29	35	42	48	54	59	65
4.5	20	24	28	32	37	41	45	22	27	32	37	42	47	52	32	39	46	54	60	66	71
5.0	21	26	31	36	41	45	50	24	30	35	41	46	52	56	35	43	51	59	65	71	

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR SIX 9/64" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor	Width of Implement in Inches																				
Speed	72"							80"							84"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5																					
2.0																					
2.5														16							17
3.0							18						18	21					16	19	23
3.5					17	19	23					19	23	26				17	21	25	28
4.0				17	19	24	27				19	23	27	31			16	21	25	29	33
4.5				19	24	27	31			18	23	27	31	35		16	20	24	29	33	37
5.0			18	23	27	31	35		16	22	26	31	35	39		17	23	28	33	36	40

Tractor	Width of Implement in Inches													
Speed	96"							144"						
	Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5														18
2.0											16	20	24	27
2.5						18	22			18	23	27	31	35
3.0				16	20	24	27		18	24	28	33	37	41
3.5			16	20	25	29	33	16	23	29	34	39	43	47
4.0			20	25	29	33	37	20	27	33	39	44	48	52
4.5		18	24	29	34	38	42	24	31	38	43	48	53	58
5.0		21	27	32	37	42	45	27	35	41	47	52	58	63

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR TWO 5/32" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

Tractor	Width of Implement in Inches																				
Speed	72"							80"							84"						
M.P.H.	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5				10	13	16	18				13	16	18	21			10	13	16	19	22
2.0			13	16	19	23	26		12	16	19	23	26	29		13	16	20	23	27	30
2.5		14	18	21	25	29	33	12	16	20	24	28	32	36	13	17	23	26	30	33	37
3.0	13	18	22	27	31	35	38	16	20	26	30	34	38	42	16	22	27	31	36	40	44
3.5	16	21	27	32	36	40	44	19	24	30	35	40	44	49	20	26	31	37	42	46	51
4.0	19	25	31	36	41	46	50	23	28	34	40	45	50	54	23	30	36	42	47	54	57
4.5	23	29	35	40	46	50	55	26	32	38	44	50	55	60	27	33	40	46	54	57	63
5.0	26	33	38	44	50	55	60	29	36	42	49	54	60	66	30	37	44	51	57	63	68

Tractor	Width of Implement in Inches													
Speed	96"							144"						
M.P.H.	Pounds N. per Acre							Pounds N. per Acre						
	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5			13	16	19	23	26	14	18	23	27	31	35	39
2.0	11	15	19	24	27	31	35	19	25	31	36	41	46	50
2.5	15	20	26	30	35	39	43	25	32	38	44	50	55	60
3.0	19	26	31	36	41	45	50	30	38	45	52	58	63	69
3.5	24	30	36	42	47	52	57	36	44	52	59	66	72	
4.0	27	35	41	47	53	59	63	41	50	58	66	73		
4.5	31	39	46	52	59	64	70	46	55	63	72			
5.0	35	43	50	57	63	70		50	61	71				

CHART FOR FOUR 5/32" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor	Width of Implement in Inches																				
Speed	72"							80"							84"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5																					
2.0														12						10	13
2.5						12	14					12	14	17					13	15	18
3.0				10	13	16	18				13	16	18	21			10	14	17	20	23
3.5			10	14	17	20	23			13	16	19	23	26			14	17	21	24	27
4.0			13	17	21	24	27		12	16	19	23	27	30		13	17	21	25	28	31
4.5		12	16	20	24	27	30		14	18	23	27	30	34	10	15	20	24	28	32	36
5.0		14	18	23	27	30	34	12	17	21	26	30	34	38	13	18	23	27	31	36	40

Tractor	Width of Implement in Inches													
Speed	96"							144"						
	Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5											10	13	16	19
2.0					11	46	16			13	17	20	23	26
2.5			10	13	16	19	22		14	19	22	26	30	33
3.0			14	17	20	23	27	13	19	23	28	32	36	40
3.5		13	17	21	24	27	31	17	23	28	33	38	43	47
4.0	11	16	20	24	28	32	36	20	26	32	38	43	48	53
4.5	14	18	23	27	32	37	41	23	30	36	43	48	54	59
5.0	16	22	27	31	36	41	45	26	34	40	47	53	59	65

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR TWO 3/16" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor	Width of Implement in Inches																				
	72"							80"							84"						
Speed	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5				10	12	14	16				12	14	16	18			10	13	15	17	19
2.0			12	15	18	20	22		11	14	17	20	22	25		12	15	18	21	23	26
2.5		13	16	19	22	25	28	11	15	18	21	25	28	31	12	16	19	22	26	29	32
3.0	12	16	20	23	26	30	33	14	18	22	26	29	33	37	15	19	23	27	31	35	39
3.5	15	19	23	27	31	35	38	17	21	26	30	34	39	43	18	22	27	31	36	41	45
4.0	18	22	27	31	35	40	44	20	25	29	34	39	44	48	21	26	31	36	41	46	50
4.5	20	25	30	35	40	44	48	22	28	33	39	44	48	53	23	29	35	41	46	51	56
5.0	22	28	33	38	44	48	53	25	31	37	43	48	53	59	26	32	39	45	50	56	61

Tractor	Width of Implement in Inches													
	96"							144"						
Speed	Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5			13	15	17	20	22	13	16	20	23	26	30	33
2.0	11	14	17	20	24	27	29	18	22	27	31	35	40	43
2.5	14	18	23	26	30	33	37	22	27	33	38	43	48	53
3.0	17	22	27	31	35	40	43	27	33	39	45	51	57	63
3.5	20	26	31	36	42	46	50	31	38	46	52	59	65	
4.0	24	29	35	42	46	52	56	35	43	51	59	66		
4.5	27	33	40	46	52	57	63	40	48	57	65			
5.0	29	37	43	50	56	63	69	43	54	63				

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR FOUR 3/16" ORIFICES. PRESSURE SETTING FOR CONTINENTAL AUTOMATIC TYPE CONTROL VALVE

Tractor	Width of Implement in Inches																				
Speed	72"							80"							84"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5																					10
2.0						10	12					10	12	14					11	13	15
2.5				10	12	14	15				11	13	15	17			10	12	15	17	19
3.0			10	13	15	17	19			12	14	17	19	21		10	13	15	18	20	22
3.5		10	13	16	18	20	22		12	14	17	20	23	25		10	15	18	21	23	26
4.0		12	15	18	20	23	25	10	14	17	20	23	26	28	11	15	18	21	24	27	30
4.5	10	14	17	20	23	26	29	12	15	19	23	26	29	32	13	17	20	23	27	30	34
5.0	12	16	19	22	25	29	32	14	17	21	25	28	32	35	15	19	22	26	30	34	37

Tractor	Width of Implement in Inches													
Speed	96"							144"						
	Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5						10	12			10	13	15	17	19
2.0				10	13	15	17		12	15	18	21	23	25
2.5			12	14	17	19	23	12	16	19	22	25	29	31
3.0		12	15	18	20	23	25	15	19	23	27	30	34	38
3.5	10	14	18	21	24	27	30	18	22	27	31	35	39	43
4.0	13	17	20	24	27	31	34	21	25	30	35	40	45	49
4.5	15	19	23	27	31	34	38	23	29	34	39	45	50	54
5.0	17	22	25	30	34	38	42	25	32	38	43	49	54	60

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR TWO 3/32" ORIFICES. PRESSURE SETTING FOR NEEDLE VALVE TYPE CONTROL

Tractor Speed M. P. H.	Width of Implement in Inches																				
	36"							40"							42"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5													17	19					15	18	20
2.0				15	18	21	24				17	20	24	27			15	18	22	25	29
2.5			17	20	24	27	30		15	17	23	27	30	34		16	20	24	29	32	35
3.0		17	20	25	29	32	37	14	19	24	28	32	36	40	15	20	25	29	34	39	42
3.5	15	20	25	29	34	39	43	17	23	27	33	38	43	47	19	25	29	35	40	45	49
4.0	18	24	29	34	39	44	48	21	26	32	38	44	48	53	22	28	34	40	45	51	56
4.5	21	26	32	39	44	48	52	24	30	37	43	48	54	58	25	32	39	45	51	56	61
5.0	24	30	37	43	48	54	59	26	34	39	46	52	58	63	28	35	43	49	56	61	66

Tractor Speed M. P. H.	Width of Implement in Inches																				
	48"							72"							80"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5				15	18	21	24	14	17	21	25	29	33	37	14	19	24	29	33	37	41
2.0		14	18	22	26	29	33	18	24	29	34	39	44	49	20	26	33	38	44	49	54
2.5	14	19	24	29	33	37	41	24	30	36	42	49	54	58	26	34	40	47	53	59	63
3.0	18	24	29	34	39	44	49	29	36	44	50	56	62	67	32	40	49	55	62	67	72
3.5	22	28	34	40	45	51	56	34	43	51	58	64	70	74	38	47	55	63	69	74	78
4.0	26	33	39	46	52	57	62	39	49	57	64	71	75	79	44	54	62	69	75	79	82
4.5	29	37	44	51	57	63	68	44	54	62	70	75	79	82	48	59	67	74	79	82	
5.0	33	41	49	56	62	68	72	48	59	68	74	79	82		54	64	72	78	82		

Tractor Speed M. P. H.	Width of Implement in Inches																				
	84"							96"							144"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5	15	20	25	29	35	39	43	18	24	29	34	39	44	49	29	37	44	51	57	62	67
2.0	21	28	34	40	45	51	56	25	33	39	45	52	57	62	39	49	57	64	70	75	79
2.5	29	36	43	49	56	61	66	32	40	49	55	62	67	72	49	59	67	74	79	82	
3.0	34	43	51	58	64	69	74	39	49	57	65	70	75	79	57	67	75	80			
3.5	40	49	58	65	72	76	79	45	56	64	72	76	80		64	74	80				
4.0	45	56	64	72	77	81		52	62	70	76	81			70	79					
4.5	51	61	70	76	80			57	67	75	81										
5.0	56	66	74	79				62	72	79											

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR FOUR 3/32" ORIFICES. PRESSURE SETTING FOR NEEDLE VALVE TYPE CONTROL

Tractor Speed M.P.H.	Width of Implement in Inches																				
	36"							40"							42"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5																					
2.0													10	12						10	12
2.5						11	13				10	12	14	15				10	12	14	16
3.0					12	14	16			10	12	14	16	19			10	12	14	17	20
3.5			10	12	15	18	20		10	12	14	17	20	22		10	12	15	17	20	24
4.0		10	12	15	18	20	23		11	14	17	20	23	26		11	15	18	21	25	28
4.5		11	14	17	20	24	26	10	13	16	20	23	26	30	10	14	17	20	25	28	32
5.0	10	13	17	20	23	27	30	11	15	19	22	26	30	34	12	16	20	24	28	32	36

Tractor Speed M.P.H.	Width of Implement in Inches																				
	48"							72"							80"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5											10	12	14	17			10	12	14	17	19
2.0					10	12	14			11	15	18	20	23		11	14	17	20	23	26
2.5				11	14	16	19		12	16	20	23	26	30	11	15	19	23	26	30	34
3.0		10	12	15	18	20	23	12	16	20	25	28	32	36	14	19	23	27	32	36	41
3.5		12	15	18	21	25	28	15	20	25	29	34	39	44	17	22	28	33	38	43	49
4.0	10	14	17	22	25	29	33	17	23	29	34	40	45	50	20	26	32	38	43	50	55
4.5	12	17	21	25	29	33	37	20	27	33	39	45	50	57	23	30	35	44	50	56	63
5.0	14	19	23	28	32	37	42	24	30	37	43	50	57	63	26	34	41	49	56	63	69

Tractor Speed M.P.H.	Width of Implement in Inches																				
	84"							96"							144"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5					15	18	20		10	12	15	17	20	23	12	17	21	25	29	33	37
2.0			15	19	21	25	28	10	14	17	21	25	29	33	17	23	28	34	40	44	50
2.5		16	20	24	28	31	36	14	19	24	28	32	37	41	23	30	36	43	50	56	62
3.0	15	20	25	29	34	39	44	18	23	29	34	39	44	50	29	36	44	52	60	67	74
3.5	18	24	29	35	40	45	51	22	28	34	40	46	52	58	34	43	52	61	70	77	84
4.0	21	28	34	40	46	53	59	25	32	39	47	54	60	67	40	50	60	70	78		
4.5	25	32	39	45	53	59	66	29	36	45	52	60	68	74	45	56	68	77			
5.0	28	36	44	51	59	66	72	32	42	40	58	67	74	81	50	63	74	84			

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

CHART FOR SIX 3/32" ORIFICES. PRESSURE SETTING FOR NEEDLE VALVE TYPE CONTROL

Tractor Speed	Width of Implement in Inches																				
	36"							40"							42"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5																					
2.0																					
2.5																					
3.0																					10
3.5							10						10	12						11	13
4.0						11	13					10	12	15					12	14	16
4.5					11	13	15				10	12	15	17				11	14	16	18
5.0				10	13	15	17			10	12	15	17	20			10	13	15	18	21

Tractor Speed	Width of Implement in Inches																				
	48"							72"							80"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5																					
2.0													11	13					11	13	15
2.5											10	12	15	17				12	14	17	19
3.0						11	13			11	13	15	19	21			13	15	19	21	24
3.5					11	14	16		11	13	16	20	23	26		12	15	19	22	26	30
4.0				11	14	16	19		13	16	20	23	27	31	11	14	19	23	26	30	35
4.5			11	14	16	19	21	11	15	19	23	27	31	35	12	17	22	26	30	35	40
5.0			12	15	19	22	25	12	17	21	26	30	35	40	15	20	25	30	35	40	45

Tractor Speed	Width of Implement in Inches																				
	84"							96"							144"						
	Pounds N. per Acre							Pounds N. per Acre							Pounds N. per Acre						
M. P. H.	40	50	60	70	80	90	100	40	50	60	70	80	90	100	40	50	60	70	80	90	100
1.5							10						11	13			11	13	16	19	22
2.0					11	13	15				12	14	16	19		13	16	20	23	27	30
2.5			10	13	15	18	21			13	16	19	22	25	13	17	21	26	30	35	39
3.0		10	13	17	20	23	26		12	16	20	23	27	30	16	21	27	32	37	42	48
3.5		13	16	20	24	28	31	11	16	20	24	28	32	36	20	26	32	39	45	51	58
4.0	11	15	20	24	28	32	36	14	19	24	28	33	38	42	24	31	38	45	52	59	66
4.5	13	18	23	27	32	37	42	16	21	27	32	38	44	49	27	35	43	51	60	67	75
5.0	15	21	26	31	36	42	47	19	25	30	36	42	49	55	31	40	49	58	67	76	85

Note: This scale shows the orifice or gauge pressure in pounds on regulator.

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MARKETING HATCHING EGGS IN LOUISIANA

By

EWELL P. ROY AND JAMES M. BAKER

Marketing hatching eggs at a selected Louisiana hatchery

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATION
W. G. TAGGART, *Director*

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PICTURE—Showing Producer Avery Boudreaux delivering hatching eggs to Hatcheryman E. P. Putnam at Putnam Hatchery, Abbeville, Louisiana.

MARKETING HATCHING EGGS IN LOUISIANA[1]

EWELL P. ROY AND JAMES M. BAKER

INTRODUCTION

One hundred five hatcheries operated in Louisiana during 1949 with an estimated capacity for handling two million eggs.[2] Of these hatcheries, 91 were commercial units and 14 were operated on a service basis by chapters of the Future Farmers of America. The commercial hatcheries comprised 97 per cent of the egg hatching capacity and the F.F.A. units 3 per cent. Seventy-seven per cent of the commercial plants were members of the Louisiana Poultry Improvement Association while only 28 per cent of the other group had this rating.

According to the improvement association there were in 1949 about 75,000 layers in hatching egg flocks in Louisiana. This number was only 38 per cent of the estimated 200,000 hens that would have been required to support adequately all the hatcheries operating at the time. The shortage of layers indicates a need for expansion of hatching egg production in the state, provided, however, production costs in the state are in line with corresponding costs in competitive areas. The local deficiency in the hatching egg supply is indicated also by the fact that Louisiana hatcheries provide only 56 per cent of the state chick requirements (Appendix Table 1).

Hatcheries in Louisiana, on the average, are relatively small. For example, they are only one-fifth as large as the hatcheries in Missouri and have a capacity of 19 eggs for every 100 chicks raised as compared with an 80-egg capacity for Missouri. If an increase in the size of the hatching operations is conducive to economy of operation, it must follow that, in this respect at least, Louisiana hatcheries operate at a commercial disadvantage. Whether the shortage in egg production is a cause or an effect of low egg-hatching capacity of the hatcheries in the state may be clarified somewhat by the succeeding pages of this study, which was de-

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[1] This study is a part of the coordinated regional egg marketing research project in which the states of Louisiana, Arkansas, South Carolina, and Mississippi are participating under Research and Marketing Act of 1946. The authors, Research Associate and Associate Agricultural Economist, respectively, wish to acknowledge cooperation given by the producers and hatcherymen which was necessary to make the study possible.

[2] Estimate based on records on file with Louisiana Poultry Improvement Association, Baton Rouge, Louisiana. This association is a part of the National Poultry Improvement Plan to eradicate pullorum and contribute to better poultry.

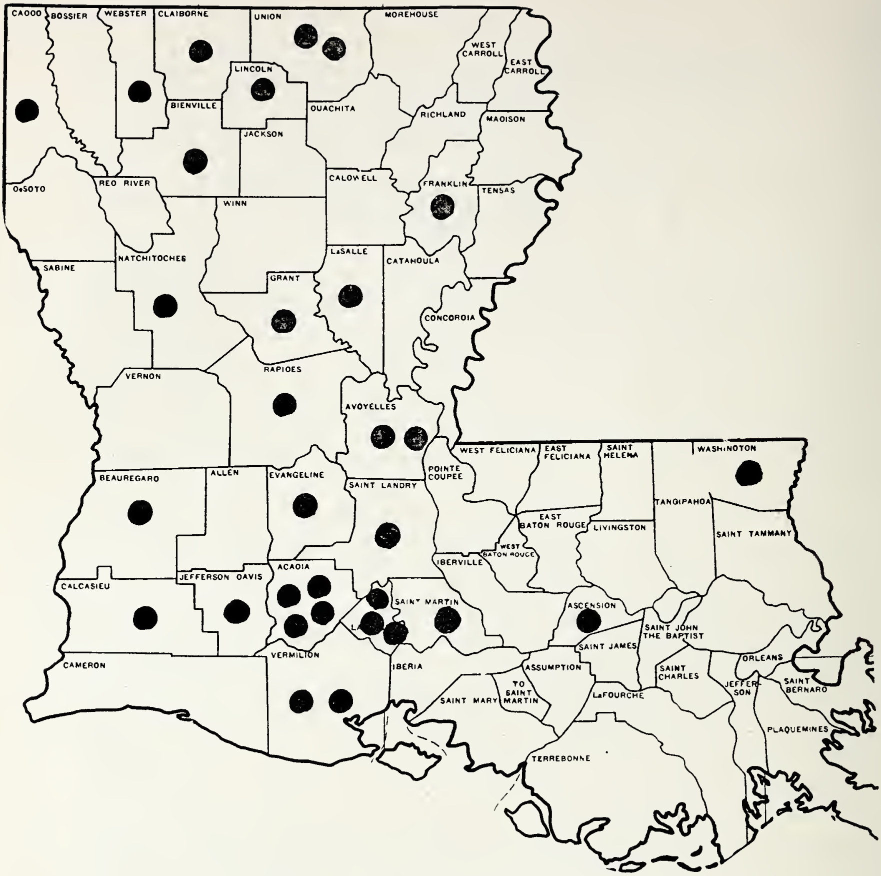

Figure 1. Location of the 31 hatcheries included in the study of hatcheries as a market for Louisiana eggs. They are widely distributed throughout the state.

signed primarily to determine why Louisiana farmers do not produce more hatching eggs.

The study was approached mainly through an examination of the working relations between the hatcheries within the state and the hatching egg producers about them. To get a true perspective of the supplier side of the producer-hatchery transactions it was believed necessary to include in the sample for study producers who have withdrawn from the hatching egg business as well as the ones actively engaged in it. The sources of data included the U. S. Department of Agriculture, Louisiana Poultry Improvement Association, egg producers located in the vicinities of the hatcheries who had patronized the hatcheries at some time since 1944, and the commercial hatcheries in the state having five or more egg suppliers and cooperating with the improvement association.

The information used in the report was obtained from producers and hatcheries on a sampling basis by personal interviews. The producers were divided into three classifications: (1) producers, totaling 64 in number, who sold eggs to the hatchery throughout the 1949-50 hatching season, and were active hatchery patrons at the time of the study; (2) 35 producers who had discontinued selling hatching eggs during 1949-50; and (3) 71 producers who had quit producing hatching eggs during the period 1945-49 and were producing only "market" eggs during 1949-50. The different classes of producers were designated as Group I, Group II and Group III, respectively. The hatchery sample included 31 hatcheries widely distributed over the state to give a good cross section of the producers patronizing hatcheries at some time during 1945-1950. The sample excluded practically all of the large hatcheries having fewer than five Louisiana egg producer patrons, and many of the small hatcheries maintaining their own laying flocks. The location of the hatcheries used is shown in Figure 1.

The study had four main objectives: (1) to establish the relationship between each group of producers and the hatchery; (2) to analyze the major factors in the business relation between producer and hatchery; (3) to determine the primary condition affecting the production of hatching eggs in Louisiana; and (4) to evaluate the findings in terms of economic opportunity to expand the production of hatching eggs.

PRODUCER CHARACTERISTICS

Comparisons were made between the groups of producers with respect to tenure, farm status, size of family and sources of income (Appendix Table 2).

Tenure—Ninety-three per cent of the 61 producers contacted in Group I were farm owners, 83 per cent of the 35 representing Group II owned their farms, and 99 per cent of the Group III producers had this farm tenure rating.

Farm Status—About two-thirds of the producers in Groups I and II and less than one-half of those in Group III were full-time farmers. The balance of the producers in all groups operated their farms on a part-time basis.

Acreage—Over 50 per cent of the producers in each group operated farms averaging less than 30 acres of cropland. Fifty-one per cent of the farms operated by Group I producers contained 61 or more acres, as compared with 49 per cent and .32 per cent, respectively, for the other two groups.

Household—Group I had 64 per cent of the households with fewer than five persons, Group II had 77 per cent, and Group III, 84 per cent. The high percentage of small families in the third group may be attributed to older people and many wholly or partly on public welfare or old-age pension.

Income—Poultry was the primary source of income for only 7 per cent of the producers in Group I, 3 per cent in Group II, and none in Group III. It was a secondary source of income for 38 per cent, 34 per cent, and 12 per cent of the producers in the respective groups, with the main source of income from crops and livestock.

Size of Flock—The range in the size of flocks studied is shown in Table 1. Fifty per cent of the producers in Group I had an average of fewer than 100 hens each, 60 per cent of the producers in Group II had laying flocks in this range, and 93 per cent of the producers in Group III, who sold only market eggs, had flock sizes of less than 100 layers. With these data at hand relatively few of the producers in any group could be classified seriously as commercial egg producers.

Table 1. Size of Flocks, by Producer Groups, Louisiana, 1949-50

Hens	Group I		Group II		Group III	
	Number	*Per cent*	*Number*	*Per cent*	*Number*	*Per cent*
Under 50	7	12	10	29	46	62
50-99	23	38	11	31	23	31
100-199	20	33	10	29	4	5
200-over	11	17	4	11	1	2
Total	61	100	35	100	74	100

In summary, egg producers were principally among home owners with families of fewer than five persons. Less than 10 per cent of the 1949-50 producers were using this business as a major source of income although poultry and eggs were important as secondary sources of financial support. Producers depended primarily on crops, livestock, and non-farm employment.

HATCHERIES IN LOUISIANA

The hatcheries included in the study depended mainly on Louisiana producers for their hatching eggs. Some of the characteristics of these hatcheries with respect to development, egg supply, egg capacity, pullorum rating, and sources of income are indicated in the Appendix (Table 3).

Development—Meat rationing during World War II had much influence on the development of hatcheries in Louisiana. Nineteen hatcheries, or 61 per cent of the 31 surveyed, were established since 1943. Seventeen, or 55 per cent, have expanded their operations since the close of the war.

Egg Supply—Thirty-two per cent of the hatcheries received their eggs from fewer than 10 patrons, 46 per cent were supplied eggs by 10 to 19 patrons, and 22 per cent were supported on an average by 20 or more flock owners. Local producers provided most of the eggs used by the hatcheries included in the study. In fact, only 7 per cent of these hatcheries depended primarily on eggs from other states, which included Kentucky, Missouri, Indiana, Iowa, and Kansas in order of their importance. The relation between the local and the out-of-state supply of eggs at the hatcheries and the percentage of hatcheries operating, by months, during 1949-50 are shown in Table 2.

Table 2. Percentages of Eggs Received by 31 Louisiana Hatcheries from Louisiana and Out-of-State Sources and Percentage of Hatcheries Operating, by Months, 1949-50

Source	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Year
							Per cent						
Louisiana	30	92	67	66	84	68	84	81	76	81	93	91	79
Out-of-state	70	8	33	34	16	32	16	19	24	19	7	9	21
Total	100	100	100	100	100	100	100	100	100	100	100	100	100
Hatcheries Operating	20	26	74	77	68	60	97	100	100	94	84	42	70

Egg Capacity—The present and the anticipated capacity of Louisiana hatcheries are indicated in Table 3. The 31 hatcherymen interviewed reported the need for 33,000 more layers to provide their hatching egg requirements, based on full capacity which had to be maintained in order to supply the peak seasonal demand for chicks. The shortage in locally produced hatching eggs was not prevalent at all of the hatcheries contacted. It was most pronounced in the northeastern, northwestern and southeastern parts of the state including portions of the New Orleans section. Since this study was made, Assumption, Livingston and other southeast parishes have increased their flocks significantly. Many hatcherymen have planned to expand the egg capacity of their hatching units on the prospect of an increase in demand for chicks which in turn is based on the rapid and widespread development of the broiler industry in Louisiana.

Table 3. Egg Capacity, Layers Required and Layers on Hand, for 31 Commercial Hatcheries, Louisiana, 1949-50

Item	Commercial hatcheries	Average per hatchery
Original egg capacity	327,844	10,576
Total egg capacity (Jan. 1, 1950)	842,414	27,175
Layers required for capacity[1]	84,241	2,718
Layers in supply flocks, Jan. 1, 1950	50,683	1,635
Layers needed to meet capacity	33,558	1,083
Total capacity; present plus anticipated[2]	1,170,758	37,766
Layers required for expected total capacity	117,076	3,777
Layers in supply flocks, Jan. 1, 1950	50,683	1,635
Layers needed to meet increase in capacity	66,393	2,142

[1] One layer required for every ten units of egg capacity.

[2] Based on expansion intention of hatcherymen surveyed.

Pullorum Rating—All hatcheries included in the survey had a pullorum rating.[1] Three per cent were classified as "clean," 42 per cent had a "passed" rating, and 55 per cent were operating as "controlled." Although a "clean" standard is the goal for all hatching egg producers and hatcheries, continuous supervision and emphasis on the importance of producing pullorum-free chicks is necessary to get them out of the "controlled" class.

Sources of Income—Only 3 hatcherymen, or 10 per cent of the ones interviewed, gave full time to the hatching business, while 8 others, or 26 per cent, had in addition laying flocks and other types of business. The remaining 64 per cent had non-farm enterprises along with their hatcheries, such as retail feed and seed stores, groceries, hardware and appliance stores, and some also taught school.

PRODUCER-HATCHERY RELATIONS

By analyzing the factors affecting the trading relations between the producers of hatching eggs and the hatcheries that use them some accounting may be made for the deficit in hatching egg production in Louisiana. The factors studied were (1) producer turnover, (2) patronage withdrawal from egg sales at hatchery, (3) management practices, (4) related marketing practices, (5) outlets for eggs, and (6) marketing problems of producers and hatcherymen.

Producer Turnover—The frequent turnover among producers of hatching eggs has caused instability in the hatching egg business and has forced some hatcherymen to follow one of three courses in order to have a steady supply of eggs. One course was to discontinue egg purchases from unstable producers and to encourage the reliable producers to increase the size of their flocks; another was to obtain a larger proportion of their eggs from other states where the supply is stable and a choice of source available; and the third alternative was to produce their own hatching eggs, which some of them were contemplating doing.

In the case of dependence on a few good local producers the hatcherymen can exert some influence and supervision over the general production and marketing practices. A summary of the turnover in producer patronage in connection with the 31 commercial hatcheries contacted is presented in Table 4. Many farmers experience a one-year tenure in hatching egg production by "feeling-out" the business, becoming dissatisfied, and quitting. There was little evidence that shifting from hatching eggs to market eggs was purely a matter of preference, as many of the larger flocks were reduced in size after the change was made.

---

[1] "Clean" denotes no reactors on two consecutive tests; "passed" means no reactors on the second test, and "controlled" denotes less than 2 per cent reactors on the second test.

Table 4. Number and Percentage of Hatching Egg Producers Entering and Leaving the 31 Hatcheries, by Hatching Seasons[1], for Selected Years

Hatching season	Number hatcheries reporting	Number producers entering per hatchery	Number producers leaving per hatchery	Per cent leaving
1945-46	23	17	9	53
1946-47	23	9	2	22
1947-48	24	14	6	43
1948-49	29	12	5	42
1949-50	31	14	6	43

[1] Hatching season extends from July 1 of one year to June 30 of the next.

The active hatching egg suppliers, or producers in Group I, reported having sold eggs to the hatchery continously for a longer period of time since 1940 than did the producers in either Group II or III, although much of their sales relations have been with two or more hatcheries. The shifting from one hatchery to another may indicate a degree of competition among hatcherymen for the eggs of certain flock owners (Appendix Table 4).

Some of the producers who had quit the production of hatching eggs during the period 1949-50 were considering returning. Among the inducements for returning were the better prices for local hatching eggs over the prices for shipped-in hatching eggs, and the wide difference between the prices of hatching eggs and the prices they were receiving for market eggs, as indicated by Figure 2. The difference between the price of locally produced hatching eggs and the ones from other states may have been due to difference in hatchability (Figure 3).

Patronage Withdrawal—It has been pointed out that the high percentage of turnover in hatching egg production in Louisiana caused instability in the hatching egg business and hampered efforts to increase volume. The reasons given by producers for withdrawing their patronage from the hatchery may reveal some of the problems involved which could or could not be corrected. Ten reasons rated according to the frequency given are presented in Table 5, where they were evaluated by points in order of the frequency and importance indicated by the producers. The reasons are discussed in the order of their rating.

Egg-Feed Price Ratio—The high cost of feed relative to the price received for eggs topped the list of reasons given by producers for discontinuing the production of hatching eggs. This reason, as evaluated on the basis of the data obtained, appears to have been overemphasized, and especially so when reference is made to the already established fact that at the same markets, prices for Louisiana hatching eggs were better than the prices for hatching eggs from other states. Relatively low gross returns which were affected by an impaired "average" price for eggs

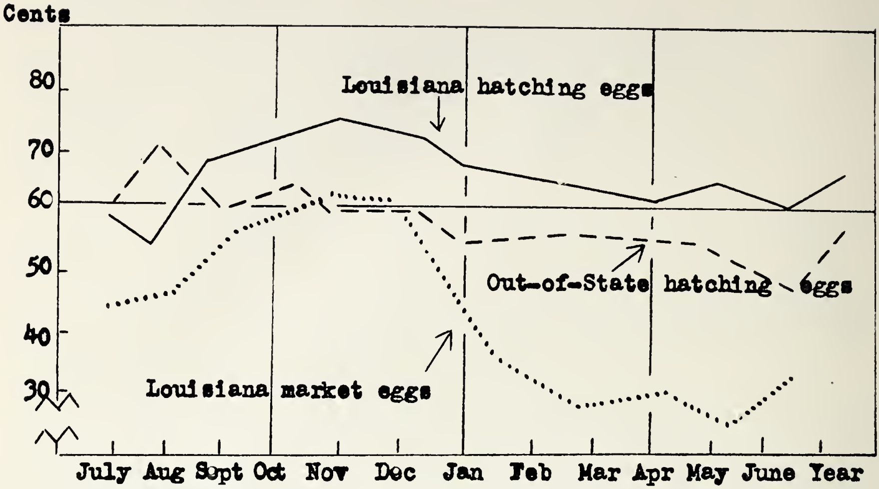

Figure 2. Prices paid per dozen at hatchery for Louisiana hatching eggs, out-of-state hatching eggs, and regular Louisiana market eggs, by months, Louisiana, 1949-50

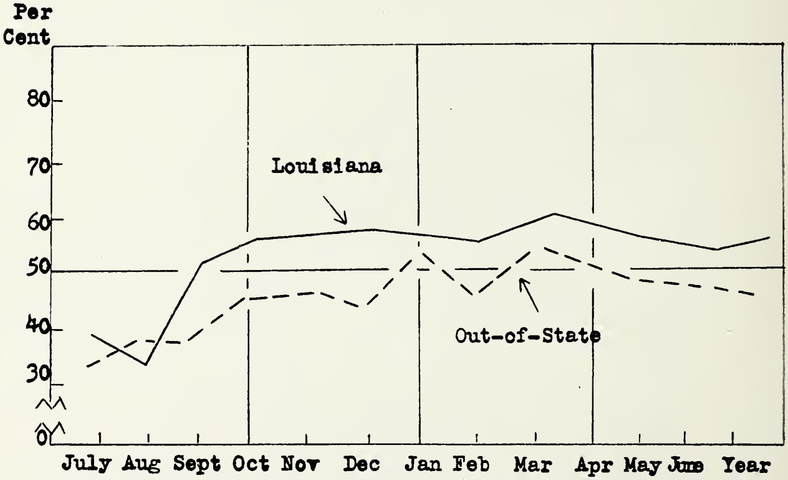

Figure 3. Percentage comparison of hatchability of Louisiana hatching eggs with out-of-state hatching eggs at 31 Louisiana hatcheries, by months, 1949-50

Table 5. Reasons Given by 129 Producers for Withdrawing from Hatching Egg Production, Louisiana, 1949-50

Reasons	Points[1]	Per cent
Unfavorable egg-feed price ratio	198	15
Producer and hatcheryman develop dissension	184	14
Diseases including pullorum in flock	179	13
Limited physical facilities	164	12
Limited time to devote to poultry	132	10
Flock small and production low	124	9
Refusal of eggs on account of breed	114	8
Short hatching season	98	7
Flockowners' age or poor health	92	7
Located too far from hatchery	83	5
Total	1,368	100

[1] Producers were asked to give from one to five reasons why they had withdrawn from production. The first reason was given a weight of 5 points; second reason, 4; third reason, 3; fourth reason, 2; fifth reason, 1.

may have been what the producer actually had in mind. The indications are that such factors as a short marketing season for hatching eggs, relatively low prices for eggs not qualifying for hatching, and a moderate rate of lay per hen contributed to an unfavorable cost-returns ratio.

Dissension—It is easy to understand that dissension between producer and hatcheryman would arise under certain circumstances and bring about the second most important reason given by producers for discontinuing the hatching egg business. Some of these causes were: misunderstanding as to the nature, provisions, or length of the contract duration with regards to hatching egg purchases; either the hatcheryman being negligent in picking up the eggs or the producer failing to deliver eggs as agreed; delinquency in payments to the producer; contentions arising over credit for feed and supplies; hatcheryman forcing the flockowner to buy the brand of feed he handles, or perhaps the hatcheryman grading the producer's eggs too strictly; and negligence on the part of the hatcheryman to test layers promptly or failure of the producer to comply with the pullorum control program.

Disease—Lack of pullorum control is always a hazard to satisfactory hatching egg production as well as marketing. Since this disease may be detected by a blood test of breeding stock, it is controllable. Its high degree of toleration by both producers and hatcherymen easily could be responsible for discontinuation of hatching egg production in many instances.

Facilities and Time—As reasons for quitting hatching egg production neither inadequate facilities nor lack of time to devote to the enterprise has any direct bearing on producer-hatchery relations. They are items chargeable entirely to the side of the producer and may not be correctible at the time. Size of flock also is a reason that rightly can be assigned to the same account. Selection of breeds of hens for hatching eggs most desirable for the available markets is the responsibility of the producer.

Short Season—Although the short marketing season for hatching eggs was given eighth place by producers as a cause for discontinuing the production of hatching eggs, the data indicate that this factor in this case was more important than the relationship between feed and egg prices. A more nearly year-round demand for hatching eggs which would provide a good outlet for a larger proportion of the yearly output would widen the margin between the cost of producing the eggs and the gross returns for them. Other closely related factors affecting cash returns for the aggregate egg supply were the reduced price for the hatching eggs cut off from the market as such by the short demand period and the prevailing unstable market for the eggs not qualifying for hatching. Only 38 per cent of the Group I producers could sell their total egg supply to or through the hatchery and the rest had to dispose of their rejected hatching eggs and the eggs of lower quality at the available "market" egg outlets.

Information on the production practices followed by producers after discontinuing the hatching egg business probably would contribute materially to the reasons for withdrawal. Of the 545 producers quitting during 1945-50, an estimated 25 per cent terminated egg production altogether. Twenty-seven per cent, or 109, of those remaining reported revision in production practices under the changed conditions. Some of the modifications reported by Group II and III producers are recorded in Appendix Table 5. Fourteen per cent of Group II and 53 per cent of Group III, respectively, changed the breed of the flock, 50 per cent stopped flock culling, 88 per cent or more ceased testing for pullorum, over two-thirds changed rations and source of feed, three-fourths reduced the size of the flock, and about two-thirds disposed of their cockerels.

On the hatchery side of the picture only 42 per cent of the hatcherymen surveyed made purchases of hatching eggs for a specified number of months. The arrangement was often of short duration. Few hatcherymen can anticipate future demand and supply conditions; therefore, they prefer to make their purchases on a current basis with no entangling committments (Appendix Table 6).

The range of services performed by hatcherymen is wide. It may include testing, culling, providing technical assistance concerning feed and housing, providing literature, holding conferences, furnishing free male birds to improve flocks, and aiding in disposing of surplus eggs. Only 23 per cent of the hatcherymen performed no personal service to egg producers for one reason or another.

Hatcherymen gave among other reasons for not purchasing hatching eggs out-of-season or market eggs at any time of the year that outlets were limited and loss in the quality of eggs, especially in summer, is hazardous, while in other cases facilities were lacking, or margin for profit was small.

Management Practices—As a standard by which egg production practices may be evaluated, use was made of a list of recommended management practices compiled by the Louisiana Agricultural Experiment Station which appears in Table 6. In this table the extent of compliance with the recommendations by the different groups of producers is indicated by the "point" method of calculation.

Table 6. Percentage of Producers Using Recommended Management Practices, by Types of Producers, Louisiana, 1949-50[1]

Recommended Management Practices	Points of Observance		
	Group I	Group II	Group III
	Per cent		
Cull flock regularly	98	77	24
Keep poultry records	51	23	5
Feed mineral mix	92	60	28
Rotate poultry yards	41	18	10
3-5 square feet floor space per bird	41	29	26
House with litter and screened pit	34	17	12
Use electric lighting	36	26	7
One nest for 1-6 layers	69	62	87
60 per cent or more pullets	89	83	34
Segregate young and old poultry	30	18	11
One rooster per 11-15 layers	49	29	18
Layers range only part of day, every day	13	0	3
Obtain chicks by April 1	69	66	51
Use wire basket for gathering eggs	40	20	11
Use steel wool, emory cloth or sandpaper to clean eggs	39	23	7
Index-of-observance[2]	53	37	22

[1] Compiled in cooperation with Dr. C. W. Upp, Head of Department of Poultry Industry, Louisiana Agricultural Experiment Station.

[2] Each item given an equal weight based on 100; the total is then divided by the number of items.

The data indicated that the producers who were active at the time of this survey, or Group I, were more observant of the recommended practices than producers in Group II or III, with an index-of-observance record of 53 points as compared with points of 37 and 22, respectively, for the other groups.

Much interest has arisen during recent years concerning the rate of lay for different breeds of hens. Analyses of the data indicate no great difference in this respect among the standard heavy breeds of layers and that management, not breed, is the main difference (Table 7). The breeding back of the particular flock is much more important than mere choice of breed. The Cornish and the Giants, among others, are exceptions because they have been developed chiefly for meat. Some hatcherymen pay more for Cornish eggs because of the local demand for Cornish chicks in some areas.

Table 7. Number of Layers, Rate of Lay, and Per Cent of Layers on Farms, by Breeds and Types of Producers, Louisiana, 1949-50

Breed	Group I				Group II				Group III			
	Number of layers	Rate of lay[1]	On farms Jan. 1	On farms previously	Number of layers	Rate of lay[1]	On farms Jan. 1	On farms previously	Number of layers	Rate of lay[1]	On farms Jan. 1	On farms previously
	No.	eggs	Pct.	Pct	No.	eggs	Pct.	Pct	No.	eggs	Pct.	Pct
New Hampshire	3,641	164	38	3	1,366	133	22	----	938	115	24	4
Other[2]	1,538	161	7	7	----	----	----	----	----	----	----	----
White Rock	1,191	170	17	10	511	139	20	6	215	127	5	8
Rhode Island Red	625	158	10	5	226	140	5	12	100	114	3	10
Other heavy breeds	451	132	6	----	56	122	6	6	72	128	2	4
Barred Rock	402	133	8	10	298	132	9	18	574	115	16	11
All Cornish	338	95	7	2	369	83	15	3	295	107	5	10
Crossbreeds[3]	265	129	5	2	373	145	5	----	151	107	4	1
All Giants	54	133	2	----	251	120	12	6	120	114	4	4
All Leghorns	----	----	----	7	386	133	6	12	307	145	4	3
Mongrel[4]	----	----	----	12	----	----	----	9	545	108	18	15
Mixed breeds[5]	----	----	----	----	----	----	----	----	805	124	15	3
No other breed kept	----	----	----	39	----	----	----	28	----	----	----	24
Totals	8,505	157*	100	100	3,836	129*	100	100	4,122	118*	100	100

[1] Rate of lay calculated by dividing total production for 1949-50 by the number of layers on farms, January 1, 1950.

[2] Included two or more pure breeds retained for hatching purposes but separated as to breed (standard heavy breeds)

[3] Includes crosses between standard heavy breeds, such as Barred Rocks x New Hampshires.

[4] Includes flocks whose breed characterstics have been diffused.

[5] Includes flocks consisting of two or more breeds whose characteristics are still ascernible, although somewhat diffused.

*Represent average rate of lay.

The more numerous the variety of eggs offered for sale to hatcherymen, the greater is the cost of hatchery operations, owing to complexities in accounting, variations in egg weights, color of eggs, and the like, which tend to lower the price of eggs to producers.

Flock Replacements—Producers purchase considerable quantities of chicks out-of-state for flock replacements (Appendix Table 7). Twenty-six per cent of the ones who were active hatchery patrons at the time of this study purchased chicks from states other than Louisiana, while the producers who had quit the hatcheries during previous years purchased out-of-state chicks to a lesser degree. Sixteen per cent of Group I producers contended they obtained better stock from other states, 2 per cent said it was customary to use shipped-in chicks, 8 per cent gave various other reasons, and 74 per cent did not obtain replacements from out-of-state.

On the whole, Group I producers purchased chicks in larger quantities than did Group II and Group III producers. Eighty-two per cent of the first group took 150 or more chicks per purchase while the other groups purchased less than 150 chicks in most instances. Seventy per cent of Group I sustained less than 5 per cent chick mortality, while there were 74 per cent and 81 per cent of Groups II and III, respectively, having this loss. One would have expected the opposite, since, on the whole, producers in Group I led the other groups in observation of recommended management practices. There is evidence, however, that Group I kept a better set of mortality records than did the other groups.

The breeding of male birds is a key factor in producing quality hatching eggs. Forty-two per cent of the active hatchery patrons had either "Record of Performance" cockerels or certified matings denoting top-flight birds. Of the patrons leaving the hatchery in 1949-50, 31 per cent had top-grade cockerels. Patrons leaving between 1945 and 1949 did not require male birds of such quality since they produced market eggs.

Related Hatchery Practices—The hatcheryman too has to follow sound business practices to keep his shop open. He must depend principally on chick customers. Some of his operational problems are presented in the Appendix (Table 8), where it is indicated that 52 per cent of the hatcheries have more difficulty in selling chicks during the spring months than in other seasons because of the intense competition from out-of-state hatcheries.

In order to attract more customers, 61 per cent of the hatcheries made deliveries along with over-the-counter sales. Hatcheries, like producers, have "surplus" problems. Eighty-four per cent of the hatcherymen reported having difficulty in selling chicks because of such conditions as bad weather and competition from other hatcheries. This competition was mainly from midwestern hatcheries and was based more on price of the chick than on the quality of the chick. However, these hatcheries experienced a shortage of chicks especially in the fall months and relied to some extent on receipts from Missouri, Tennessee, Texas, Mississippi and Indiana, in order of their importance. Advertising was employed by 90 per cent of the hatcheries to increase chick sales.

Forty-two per cent of the hatcheries replaced all chick losses of their customers, 23 per cent of them replaced one-fourth to three-fourths of the loss, 25 per cent made no replacements, and 10 per cent had no definite replacement policy. Eighty per cent of all hatcherymen slaughter their culls while 20 per cent slaughter some and sell the others at a discount.

Chick Purchases and Prices—Prices paid for chicks by producers and the prices received for them by hatcherymen during 1949-50 are compared in the Appendix (Table 9). Where the three different groups of producers paid 16 cents, 15 cents, and 14 cents for heavy breed, straight-run chicks, respectively, the hatchery received an average of 15 cents. Sexed chick prices were somewhat higher because of the additional cost of sexing. The sale of sexed chicks from Louisiana hatcheries is relatively small, which may be due to the lack of trained sexors and the custom of producers' buying straight-run chicks where the pullets are retained for egg production and the cockerels are raised for meat. The price of chicks in the fall is usually two or three cents higher per unit than in the spring because of higher fall egg prices and lower hatchability at this season.

Pullet chicks of the light breeds, such as the White Leghorn, command a premium in the market because of egg laying ability and also because of the almost total loss of the discarded cockerels. Although it may be suggested that Leghorn cockerels be used for broiler purposes, data are not at hand to compare their quality and production costs with that of some of the heavier breeds.

The New Hampshire was reported the most popular breed of chicks purchased by Louisiana producers during the period of this study (Table 8). The Cornish, Giants, and certain other breeds are used primarily in southwestern Louisiana. In other parts of the state four breeds were preferred in this order: New Hampshire, White Plymouth Rock, Barred Plymouth Rock, and Rhode Island Red. Most hatcherymen have to carry a variety of breeds in order to meet the wishes of a satisfactory number of customers.

Commercial hatcheries deal with a diversity of customers (Table 9). Only 16 per cent of the hatcheries sold chicks to broiler producers; consequently, the hatcheries must depend on the localized demand of farmers and town-folk whose purchases are relatively small, or about 40 to 100 chicks. Many of the hatcheries in the state have outgrown or oversaturated the local demand for chicks yet their operations are not sufficiently large to expand sales beyond the local area. Only eight hatcheries sold chicks outside the state, and these went mostly to the neighbor-

Table 8. Popularity of Breeds of Chicks Sold, as Reported by 31 Commercial Hatcherymen, Louisiana, 1949-50[1]

Breed	Total points	Per cent
New Hampshire	112	39
White Plymouth Rock	65	22
Barred Plymouth Rock	48	17
Rhode Island Red	14	5
All crossbreeds	12	4
Dark Cornish	10	3
White Leghorn	8	3
Jersey Black Giants	7	2
White-Laced Red Cornish	4	2
Other[2]	10	3
Total	290	100

[1] Four points given for most popular breed at retail level; 3 for second place; 2 for third place; 1 for fourth place.

[2] Other breeds here include Wyandottes, Orpingtons, Australorps, White Giants, Brahmas, and Partridge Rocks.

ing states of Arkansas, Texas, and Mississippi. Most of the advertising is local and is not sufficient in scope to attract larger and more distant customers. Also, chicks coming from out-of-state, often at a lower price, greatly depress the demand for local chicks in some areas, and many hatcheries experience difficulty in meeting this competition.

Table 9. Weighted Average Size Purchase of Day-Old Chicks, by Types of Purchasers, 31 Commercial Hatcheries, Louisiana, 1949-50

Type of purchaser	Weighted average purchase at hatcheries[1]	Percentage of hatcheries reporting sales
	No. of chicks	*Per cent*
Townspeople	40	100
Local farmers	100	100
Flockowner-suppliers[2]	229	61
Semi-broiler raiser[3]	357	36
Broiler raiser	802	16
Wholesaler	861	45

[1] Weighted on the basis of replies from hatcherymen as to the type of customer sold to and the average size purchase made.

[2] Some flockowners obtained their chicks through custom hatching.

[3] Those broiler raisers operating on a small, part-time scale.

Related Marketing Practices—The level of marketing practices attained by egg producers gives some indication of the quality of eggs marketed. Consumers as a rule prefer clean, fresh, infertile eggs. Hatcheries demand clean, well-sized, fertile eggs of as high a hatchability as possible. Producers in Groups I and II had to satisfy both consumer outlets and hatcheries since the latter market could not absorb all eggs produced. Group III catered mainly to consumer outlets.

All three producer groups were compared relative to a list of recommended handling practices which were partly recommendations by the Louisiana Agricultural Experiment Station and partly by the 31 commercial hatcheries surveyed (Table 10). Producers in Group I had an observance rating of 76 points, Group II, 65 and Group III, 31 points. The producers in Group I adopted recommended hatching egg handling practices to a greater extent than did those in Group II and adopted market egg handling practices to a greater extent than did those in other groups.

It would appear that the strict egg handling practices imposed by hatcherymen carried over also for the market eggs being produced. Producers in Group I probably found that adopting the better practices for handling hatching eggs also paid off when they marketed their regular market eggs; otherwise, they would not have bothered grading, packing, and cooling their market eggs. Producers in Group II treated their hatching eggs well but did not seem to adopt these recommended practices for their market eggs to the same degree as did Group I. Since Group III producers were for the most part home or "back-yard" producers they failed to adopt most of the practices to any great extent.

Table 10. Handling and Marketing Egg Practices Followed, by Groups of Producers, Louisiana, 1949-50[1]

Practices	Producers		
	Group I	Group II	Group III
	Per cent		
Gather eggs two or more times daily	75	51	26
Grade hatching eggs[2]	97	94	*
Grade market eggs	70	54	58
Hatching eggs weigh at least 24 ounces	86	81	*
Pack hatching eggs after cooling	70	74	*
Pack market eggs after cooling	47	18	18
Pack hatching eggs in cases	97	91	*
Pack market eggs in cases or cartons	42	16	11
Hold hatching eggs in a cool place	90	77	*
Hold market eggs in a cool place	77	73	47
Sell hatching eggs at least once per week	100	100	*
Sell market eggs at least twice per week	39	18	27
Prevent jarring hatching eggs in transit	93	100	*
Index-of-observance[3]	76	65	31

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[1] Practices recommended partly by hatcheries and partly by Louisiana State University Agricultural Experiment Station.

[2] Grade on at least one factor such as size or cleanliness.

[3] Each practice weighted by per cent of producers following recommendation.

*No hatching eggs produced.

Outlets for Eggs—Although one may be chiefly in the hatching egg production business and have the hatchery as a good market for this product it has been indicated that only about 56 per cent of the 1949-50 egg output qualified for hatching. The balance consists of market eggs of varying qualities and must be sold as such. The distribution of the eggs produced by the active hatchery patrons and by producers who are now producing only market eggs is shown for 1949-50 in Figure 4. Group II producers omitted in the figure operated under the same marketing conditions as did Group I.

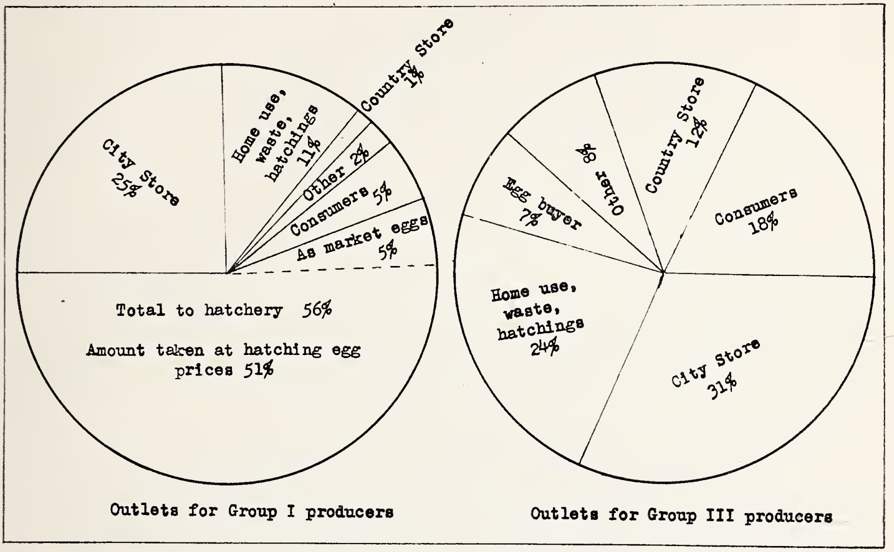

Figure 4. Outlets used for hatching eggs and market eggs produced by Group I and outlets used for the market eggs produced by Group III, Louisiana, 1949-50

Although 56 per cent of the yearly production from hatching egg flocks qualified for hatching, on the average, only 51 per cent was taken by the hatchery and the other 5 per cent had to be sold at market egg prices along with the 44 per cent of eggs not acceptable for hatching. Twenty-five per cent of the "market" eggs were distributed to stores and institutions in the city and the rest were distributed to country stores, consumers, other dealers, and farm use. Group III producers used a wide range of market outlets with little concentration of eggs at any one, as shown by the figure. This group had shifted from specialization in hatching eggs to the operation of a more or less utility type of egg enterprise.

Egg Marketing Problems—Problems connected with the marketing of hatching eggs are varied and numerous. The hatcheries absorb but few market and cull eggs even though every producer has them to dispose of along with his hatching eggs; also, the usual short seasonal demand for the hatching eggs causes serious marketing problems. Some of the reasons given for these conditions are presented in the Appendix (Table 10).

Most hatcheries buy hatching eggs on the dozen basis with little regard for hatchability. Sales of market eggs are mainly on an ungraded basis. Producers report having difficulty in selling "market" eggs to the hatchery during summer and early fall when the quality is not so good, or when there is a high percentage of pullet eggs. In the spring when other markets are congested by heavy egg production, producers have difficulty in disposing of their eggs. The main source of market news concerning hatching egg prices is from prearranged verbal or written contracts between producers and the hatchery. Market egg price information is obtained mainly through stores and by word-of-mouth. Producers are usually well informed on the price of hatching eggs but less informed about the price of market-run eggs.

The distances eggs were transported to the first buyer varied somewhat. Fifty-seven per cent of the active hatching patrons, or Group I producers, traveled 6 or more miles to market, 63 per cent of Group II producers did likewise, and 18 per cent of Group III traveled this distance. Evidently the last group traded nearer home, possibly at the country store. Premiums in goods is still a basis for much of the egg trade from small flocks and often works to the disadvantage of the producer since the price for the eggs may be greatly reduced.

SUMMARY AND CONCLUSIONS

1. The study shows that during 1949-50 there were 75,000 layers in hatching egg flocks in Louisiana when 200,000 would have been needed to support adequately the hatcheries in operation at the time. The size of the laying flocks as well as the size of the hatcheries was relatively small. Seventy-one per cent of the flocks had fewer than 100 hens, and the 31 hatcheries contacted had an average capacity of only 10,576 eggs. Less than 10 per cent of the 170 flock owners interviewed received the major portion of their income from the sale of poultry products. Because of the indicated shortage in hatching eggs this study was undertaken to determine why farmers do not increase their output.

2. Thirty-six per cent of the farmers entering hatching egg production in the state since 1944 were still in the business during 1949-50. The instability of the enterprise had caused many producers to shift from hatching egg to market egg production. As a result, some hatcherymen had to look for new sources of egg supply. An unfavorable egg-feed price ratio was given by 15 per cent of the producers as the main reason for discontinuing the production of hatching eggs, although the prices they received for their eggs were higher than the prices netted out-of-state producers at the same Louisiana markets. The difference in price

was attributed to the better hatchability of the Louisiana eggs. It was evident that good production and marketing practices were the factors that kept many producers in the hatching egg business.

3. Three economic principles should be considered before one enters hatching egg production in Louisiana. The first is the relation between production costs and net market prices of eggs in Louisiana as compared with similar conditions in competitive areas; secondly, the hatching egg business must offer at least as good economic advantages as alternative local enterprises; and third, the egg markets available to Louisiana producers must be as satisfactory as the markets afforded producers in competitive states.

4. The data indicate that, in respect to the first two principles, Louisiana hatching egg producers are in a favorable position. However, much difficulty is attached to the third, as only 56 per cent of the output of Louisiana hatching egg producers during 1949-50 was offered for sale at the hatcheries and only 51 per cent was taken as such. This apparent "surplus" of hatching eggs, which comprised 5 per cent of the total egg production, along with the 44 per cent of the output not qualifying for hatching had to be sold as market run eggs and compete with the eggs from commercial and "backyard" producers. Another obstacle, and probably the most important one, encountered by hatching egg producers was the short seasonal demand for hatching eggs. This difficulty may be attributed to the corresponding seasonal demand for chicks at the hatcheries.

5. The hatcheryman is a middleman who has to balance his purchases of hatching eggs with his orders for chicks. For his egg purchases to increase, the demand for chicks must increase. And to offer producers a more nearly year-round market for their hatching eggs he must receive his chick orders on that basis. Therefore, the primary need of the local hatchery in Louisiana is a steady demand for chicks. The lack of this kind of demand soon may be greatly alleviated by the rapid development of the broiler industry in the state. No movements are in progress in Louisiana that promise to improve the unfavorable conditions connected with the disposition of "market" eggs, and no data are at hand which would suggest a satisfactory procedure for marketing these eggs under existing conditions. Further research on this problem is needed.

In conclusion, the findings of the study indicate that when the hatcheries of Louisiana can offer the local producers markets as good as the ones provided producers in competitive areas, and when similar conditions prevail with respect to outlets for market run eggs, then Louisiana farmers may be expected to produce more hatching eggs.

APPENDIX

Table 1. Egg Capacity of Hatcheries, Chicks Hatched, and Chicks Raised, by Selected States and United States, with Comparisons, 1948[1]

Sate or Area	Average egg capacity per hatchery[2]	Percentage egg-capacity is of U.S. egg capacity	Number of chicks hatched by hatcheries	Chicks raised on farms	Percentage hatchings were of state needs	Egg capacity per 100 chickens raised
	Thousand	*Per cent*	*Thousand*	*Thousand*	*Per cent*	*Number*
New Hampshire	39	1.6	26,892	4,457	603	126
Missouri	138	9.0	82,000	39,175	209	80
California	121	3.4	69,949	26,591	263	45
Louisiana	25	.5	5,076	9,029	56	19
South Central[3]	54	10.0	131,539	150,442	87	44
United States	78	100.0	1,262,345	745,401	169	47

[1] *Agricultural Statistics,* 1949, Bureau of Agricultural Economics, U. S. D. A., Washington, D. C.

[2] This capacity is for a 3-week period and may be repeated several times during the year.

[3] Includes states of Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas.

Table 2. Characteristics of Producer Sample, By Types of Producers, Louisiana, 1949-50

Item	Group I	Group II	Group III
	Per cent		
Tenure:			
Owner	93	86	99
Renter	7	14	1
Farming Status:			
Full-time	64	66	46
Part-time	36	34	54
Acres of cropland operated:			
Less than 30	56	51	66
30 or more	44	49	34
Acres in farm:			
Less than 61	49	51	68
61 or more	51	49	32
Primary source of income:			
Poultry and poultry products	7	3	0
Crops and/or livestock	62	66	47
Non-farm	31	31	53
Secondary source of income:			
No secondary source	10	14	35
Poultry and poultry products	38	34	12
Crops and/or livestock	44	43	49
Non-farm	8	9	4

Table 3. Some Characteristics of the 31 Commercial Hatcheries Sampled, Louisiana, 1949-50

Item	Commercial Hatcheries	
	Number	Per cent
Year hatcheries established:		
Before 1943	12	39
1943-45	9	29
1946-July 1949	10	32
Period of last hatchery expansion:		
Before 1946	5	16
1946-July 1950	17	55
No expansion since established	9	29
Number of supplier-patrons:		
5-9 patrons	10	32
10-19 patrons	14	46
20-over	7	22
Primary source of hatching eggs:		
Louisiana	28	90
Other states	3	10
Business besides hatchery:		
Poultry farm and other enterprises	8	26
Non-farm enterprises[1]	20	64
No secondary business	3	10

[1] Includes retail, feed and seed stores, hardware, teaching, etc.

Table 4. Producer-Hatchery Relations, by Groups of Producers, Louisiana, 1949-50

Item	Group I	Group II	Group III
		Per cent	
Sold to hatchery less than six years since 1940	71	80	91
Sold to hatchery six years or more since 1940	29	20	9
Sold eggs to one hatchery since 1940	57	74	80
Sold eggs to two or more hatcheries since 1940	43	26	20
Also sold market eggs and culls to hatchery	38	29	*
Hatchery made no purchases other than hatching eggs	62	71	*
Intend to sell to hatchery again	*	11	8
Do not anticipate selling again	*	29	69
Undecided	*	60	23

*Item not applicable.

Table 5. Percentage of Changes Made in Production Practices by the 109 Producers Discontinuing Hatching Egg Production, Louisiana, 1945-1950

Practices	Group II	Group III
Number of Producers	35	74
	Per cent	Per cent
Kept same breed	86	47
Changed breed	14	53
Continued culling flock	57	45
Discontinued culling	43	55
Continued pullorum testing	11	12
Discontinued testing	89	88
No change in ration	34	30
Changed feeding ration	66	70
Maintained production facilities	83	64
Discontinued maintenance	17	36
No change in flock size	26	8
Decreased flock size	74	74
Increased flock size	6	18
No change in chick source	34	36
Changed source of chicks	66	64
Retained roosters	74	62
Disposed of roosters	26	38

Table 6. Actions of Hatcherymen Affecting Producer-Hatchery Relations, by Number and Percentage of Hatcheries, Louisiana, 1949-50

Action	Hatcherymen Number	Hatcherymen Per cent
Reason for Purchasing More Louisiana Eggs:		
Better hatchability and control of flocks	12	39
Aids local business	3	10
Sufficient egg supply	7	23
Other[1]	9	28
Purchasing Arrangements with Supplier Patrons:		
Egg purchases cease when chick sales drop	10	32
Purchases made for specified number of months	13	42
Other[2]	8	26
Service Performed by Hatcherymen:		
Provides testing, culling, technical assistance and literature	21	67
Testing and culling only	3	10
Performs no personal services	7	23
Reason for not purchasing Off-Season Hatching and Cull Eggs:		
No market outlets	7	23
Loss in quality too great	7	23
Other[3]	7	24
Do purchase off-season and cull eggs	10	32

[1] Other includes: hatcherymen will purchase more eggs provided they are derived from large flocks or will expand their own flocks.

[2] Purchases cease at discretion of hatcheryman or upon notice to producer.

[3] Other includes: flockowners dispose of layers early in spring; surplus of such eggs is too great to handle; market prices are high enough to absorb these eggs.

Table 7. Flock Replacements, by Types of Producers, Louisiana, 1949-50

Item	Group I	Group II	Group III
	Per cent		
Home hatched chicks	0	5	11
Purchased locally	48	60	66
Purchased out-of-state	26	17	14
Custom hatched chicks	23	9	5
No replacements	3	9	4
Obtained chicks from approved hatchery[1]	93	74	74
Obtained chicks from unapproved hatchery	4	12	11
No purchases	3	14	15
Purchased less than 150 chicks	18	74	71
Purchased 150 or more	82	26	29
Obtained better stock out-of-state	16	11	7
Customary to purchase out-of-state	2	3	3
Other reasons[2]	8	3	3
No purchases out-of-state	74	83	87
Experienced less than 5% mortality	70	74	81
Experienced 5% or more mortality	30	26	19
Roosters from own stock	12	6	27
Louisiana R O. P.[3]	20	20	4
R. O. P. other than Louisiana	10	6	0
Non-pedigreed stock	46	63	41
Certified matings[4]	12	5	1
No roosters	0	0	27

[1] Approved hatcheries are those co-operating with the National Poultry Improvement Plan.

[2] Includes obtaining rare breeds outside of Louisiana, lower prices per chick, etc.

[3] R. O. P. refers to Record of Performance Roosters under N. P. I. P.

[4] Cockerels coming from flocks headed by R. O. P. roosters.

Table 8. Flock Replacement Problems of Hatcherymen Reporting for 31 Commercial Hatcheries, Louisiana, 1949-50

Item	Number	Per cent
Sales most difficult in spring	16	52
Sales most difficult in winter	6	19
Sales most difficult in other seasons	4	13
No difficulty	5	16
Slaughter all culls	25	80
Slaughter some, sell others	4	13
Sell all at discount	2	7
Over-the-counter sales	9	29
Sales with deliveries[1]	22	61
Replace all losses	13	42
Replace 25% to 75% of the loss	7	23
No replacement	8	25
No set policy	3	10
Advertise[2]	28	90
No advertising	3	10
Cold weather harms sales	6	19
Competition from other hatcheries[3]	13	42
Other reasons[4]	7	23
No difficulty in sales	5	16

[1] Includes truck, taxi, auto, parcel post.

[2] Includes radio, newspaper, journals, theaters, etc.

[3] Competition from local, intra-state and inter-state hatcheries

[4] High feed costs, starting chicks late in spring, etc.

Table 9. Prices paid by Different Groups of Producers and Prices Received by Hatcheries, by Types of Chicks, Louisiana, 1949-50

Type of Chick	Average Price Paid by Producers			Average price received by 31 commercial hatcheries
	Active hatchery patrons	Patrons leaving 1949-50	Patrons leaving 1945-49	
	Cents			
Sraight-run:				
Heavy breeds[1] (all year)	15.6	15.0	14.4	14.8
Sexed:				
Heavy breed pullets	19.4	29.5	21.0	19.0
Light breed pullets[2]	*	30.0	22.7	29.7
Cockerels, day-old, any breed, sexed or unsexed[3]	28.1	16.9	13.1	*
Custom hatching per egg	.03	.04	.03	.04

[1] Heavy breeds include New Hampshires, Barred Rocks, White Rocks, Rhode Island Reds, and White Wyandottes.

[2] Light breeds include Leghorns, Anconas, Minorcas.

[3] High cost (28.1 cents) due to purchase of LSU Louisiana R. O. P. wing-banded Cockerels.

*No purchases made.

Table 10. Egg Marketing Problems Encountered by Different Groups of Producers, Louisiana, 1949-50

Problem Item	Group I	Group II	Group III
	Per cent		
Outlet for culled eggs:			
Home use only	33	21	44
Home use and sale to market	56	72	56
Home use and sale to hatchery	11	4	*
Seasonal difficulty of hatching egg sales:			
None	30	17	*
Summer	25	11	*
Fall	15	29	*
Other seasons or entire year	30	43	*
Seasonal difficulty of sales to other markets:			
None	48	38	49
Spring	50	62	49
Other seasons	2	0	2
Premium in trade:(market eggs)			
No premium	17	22	33
5 cents or less per dozen	19	33	25
Over 5 cents	6	4	15
Cash paid always	58	41	27
Basis of sale to hatchery			
Hatchability scale	3	6	*
Straight dozen	90	89	*
Other	7	5	*
Basis of sale to other markets:			
Current receipts (ungraded)	81	91	93
Graded	19	9	7
Source of market news (hatchery):			
Contract (verbal or written)	95	100	*
Other sources	5	0	*
Source of market news (other markets):			
Store	44	28	44
Word-of-mouth	18	28	24
No news	14	31	13
Other sources	24	13	19
Price known at hatchery:			
Always	100	97	*
Never	0	0	*
Sometime	0	3	*
Price known at other markets:			
Always	64	36	41
Never	0	6	7
Sometime	36	58	52
Distance hauled to primary buyers:			
Less than 6 miles	43	37	82
6-19.9 miles	48	60	16
20 or more miles	9	3	2
Months sold to hatchery:			
Less than 5	21	49	*
5-9	62	51	*
10 or more	17	0	*

*Item not applicable.

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THE GROWTH PATTERN OF THE CORNISH FOWL

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ABSTRACT

The purpose of this work was to make a basic growth study of the Dark Cornish fowl, *Gallus domesticus.* The magnitude of certain measureable increments for mass, volume and length has been ascertained at regular time intervals. The inter-relationship of these growth processes has been recognized and analyzed to a certain extent. Sex differences for the various criteria measured have been detected.

This breed of domestic chicken was of particular interest because it has proved to be a very potent source of economically acceptable genetic diversity in recent years. It has been shown to possess fleshing qualities not found in other breeds. Further, its genetic combining ability when crossed with certain other breeds for meat production has proved to be very favorable. It was thought that the growth characteristics of this breed should be examined. Its basic growth processes have not been so fully explored from a correlative viewpoint heretofore.

In February 1949, 384 day-old chicks of the Dark Cornish breed were initiated into the study. It was thought that the stock available for use was representative of the breed. The time interval for the investigation covered 28 weeks which allowed the subject stock to attain near-maturity dimensions. Five criteria of growth were measured during this time. These processes included body weight, gross length of the tarsometatarsus, anterior body depth, gross length of the sternum and anterior breast width. Appropriate scales and calipers were used to secure measurements of the above criteria at regular, pre-determined intervals.

The growth progression data for the various processes measured have been summarized, tested for variability and analyzed using the methods of correlation and regression. It was thought that this would furnish a valid means of determining, at least in part, the inter-relationship of the several criteria studied. The means, standard deviations, and coefficients of variability were secured for all data. Simple correlation and regression coefficients have been calculated using all possible combinations of the five growth measurements taken. In addition, certain inter-age and intra-age correlations were computed when it was considered that such might add to the value of the analysis. The age of onset of statistically significant sex differences for weight, length of tarsometatarsus, length of sternum and anterior body depth were determined.

One tendency noted was that after one week's growth, the body weight, length of tarsometatarsus, length of sternum and anterior body depth were correlated to a highly significant degree. This was found to be true for both sexes. The above criteria when studied in relation to breast width generally indicated a low grade relationship or were not related at all.

In most instances the regression tendencies are fairly well stabilized by the fourth week. The instability noted prior to this time may be due to growth adjustments taking place in the young chick.

Significant sex differences appear for weight, shank length, keel length and anterior body depth at an early age. Of particular interest was the detection of a highly significant sex difference in the length of the tarsometatarsus for day-old chicks.

The Growth Pattern of the Cornish Fowl

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INTRODUCTION

Better selection methods for more desirable growth characteristics are being sought constantly by those interested in economic improvement of domestic animals. In recent years it has come to be recognized that weight, taken alone, is not entirely satisfactory as the measure of growth. This is true with all meat animals but particularly so with poultry where the consumer often makes his purchase after an appraisal of the whole dressed bird.

The purpose of this study was to analyze objectively and make a correlative study of five primary growth criteria in a strain of Dark Cornish fowl. The development of the stock was followed from day-old through the twenty-eighth week. Weekly progress data based upon body weight, shank length, anterior body depth, length of sternum, and breast width were collected and analyzed.

The Cornish fowl suited this study most adequately. It is the domesticated breed of *Gallus domesticus* which probably is receiving the greatest current use in improving the meat qualities of the chicken. It is a closely feathered bird, actually sparsely feathered along the breast, which fortunately tends to minimize certain measurement errors.

These data, in a sense, provide information on the speed of growth processes concerned with mass, volume and length of the long bones. In addition the breast width study furnishes a measure of the marketability or consumer appeal of the individual carcass. These measureable growth processes are, of course, not entirely independent of one another, but when observed separately do tend to disclose facts which may improve one's ability to select superior individuals.

EXPERIMENTAL PROCEDURE

This study was initiated with three hundred and eighty-four Dark Cornish chicks. The parent stock of these chicks was secured from the Michigan State College. The chicks were hatched February 12, 1949. They were wing-banded with serially numbered bands for identification, sexed and the sex recorded. The sexes then were randomly mixed and no further distinction as to sex was made except that this information was used in securing a non-biased estimate of breast width by sex.

In the afternoon of the hatching date the chicks were placed in electrically operated, thermostatically controlled, battery-type brooders. The chicks were allocated to diffierent compartments at random. About 45 chicks were allotted to each section of the battery brooder. A commercial all-mash starter ration was fed for the first four weeks, that is, during the full time that the chicks were brooded in the batteries. Fresh water was available at all times.

At the end of four weeks the chicks were moved to the floor. They were housed in four adjacent sections (each 10' x 12' in size) of a continuous-type brooder house. Approximately 95 chicks were allocated to each room and this allotment was made at random. Necessary warmth was provided by electrically heated hovers, thermostatically controlled. At this age the birds were fairly well feathered and, because of the temperate weather, very little brooder heat was required.

All birds received the same commercially prepared growing mash ration plus a grain mixture of cracked yellow corn, Kafir and a red milo, free choice. The mash ration which was fed for the first ten days after the birds were placed on the floor was supplemented with sulfaquinoxaline at the rate of 0.025 pounds per 100 pounds of feed. After that time the chicks received sulfaquinoxaline in the drinking water. This coccidiosis preventive therapy was continued through the twelfth week. The medication was administered at the rate of 30 cubic centimeters per gallon of water. The coccidiastat was used two days with a three-day interval between treatments. This is in accordance with recommendations of Grumbles, et al (1949). The material used was a buffered solution of sulfaquinoxaline sodium, each 100 cubic centimeters containing 3.44 grams of sulfaquinoxaline. No coccidiosis was observed during the trial although isolated lesions were observed in the intestine after the second week.

The initial measurement of the shank length (tarsometatarsus) was secured by the use of a pair of fairly stiff-action dividers. The sharp points of the dividers had been filed down and flattened somewhat to avoid possible injury to the chick. The measurement was taken from the sole of the foot to the top of the hock joint flexed to a 90 degree angle. In other growth studies this measurement has been found to be highly correlated with the actual length of the dissected tarsometatarsus bone (Burmester and Lerner, 1937). The distance between the separated points of the dividers was read from an L. S. Starrett metric scale calibrated to 0.5 millimeter.

An attempt was made to secure a measurement of the anterior body depth of the day-old Cornish chicks; however, owing to the flexibility of the thoracic basket this was not possible. The only measures of growth secured for the day-old chicks were weight and shank length.

At the end of the first week measurements were secured for weight, shank length and anterior body depth. These criteria of growth were measured through the next eleven weeks. These weekly growth data were collected and analyzed for all birds living at the end of the twelve week period. One hundred seventy-five males and 179 females comprised this group.

Beginning with the fourth week and at each four-week growth interval thereafter through twenty-eight weeks, additional measurements were taken for length of keel (sternum) and width of breast.

After the twelfth-week data were collected the sample under study was reduced to 105 males and 105 females. All of the data secured at four-week intervals from the fourth week to the twenty-eighth week were analyzed for those birds still living at the end of the twenty-eight week period. These totals were 101 males and 96 females.

The birds retained for study after the twelfth week were housed in an open-air type house and allowed approximately four feet of floor space per bird. No cannibalism was observed throughout this study. On May 25, in the fifteenth week of study, the birds were allowed to range on yards sodded to Dallis and mixed native grasses.

On June 29, in the twentieth week, the housing and yard facilities were partitioned and the sexes were maintained in separated pens. Up until this time very little sexual activity was observed. It is recognized that the initiation of sexual activity does not mark the beginning of the period when the presence of one sex may influence the growth of the other. The sexes were not separated until this late date in order to maintain as nearly the same environmental influences as possible, as long as possible. There is a question as to when the competition and interference of the sexes exerts as great a deleterious influence on growth data as the separation of the sexes into separate environments. The feeding and watering facilities as well as floor space and managemental practices were provided to incur the minimum of competitive influence throughout the trial. Also, every effort was made to treat all lots, where separation into lots was necessary, as uniformly as possible.

The weight measurements taken during the trial were read from a Hanson gram scales graduated to one gram. The linear measurements for shank length, anterior body depth, and keel length were secured by the use of dividers or slightly curved outside calipers. The size of these instruments was increased as growth of the stock progressed. The measurements were read from an L.S. Starrett metric scale graduated to 0.5 millimeter.

The measurement of breast width was an adaptation of the lead tape method of Bennion (1944). This measurement was first taken at four weeks of age and was repeated at four-week intervals thereafter through the twenty-eighth week. Lead solder wire was molded over the breast of the bird just posterior to the anterior tip of the sternum or keel with each end of the wire pointing toward the intersection of the femur. A midpoint on the wire was predetermined and this point was placed as nearly in the center of the keel line as possible. The distance between the flattened tips of the solder wire, as measured on a metric scale, provided the breast score data.

The length of the wire used for each age was determined by the average length of the keel for that sex and age. Just prior to the time for securing all growth measurements, a 20 per cent sample of each sex was taken randomly and the keel length measured. These keel lengths were averaged by sexes. Then the solder wire to be used was cut to one-half the average keel length for the sex and age. These data are presented in Table XI. It was thought that this method would provide a standard system which could be used for any age. It was tested on Dark Cornish birds of various ages before the study was initiated. All of these tests indicated that breast width and length of sternum developed along similar patterns and seemed to indicate an acceptable means of securing the breast width score.

The formulae and statistical procedure used in the analysis of the data were taken from Snedecor (1946).

REVIEW OF LITERATURE

The collection and analysis of basic growth information on the fowl has followed various patterns and approaches in recent years.

An elementary study of the normal growth progression for the domestic fowl was reported by Kempster (1951). Five breeds of chickens were weighed at weekly intervals over a forty-week period. No criteria for growth other than body weight were considered in this work. Even though considerable inter-breed variability for growth characteristics is known to exist and the genetic basis for growth and form is being progressively altered, the data presented are nonetheless interesting. A comparison of the weights by sexes at four, eight and twelve weeks is presented. The weight is given in pounds to the nearest one-hundredth.

	S. C. White Leghorn		White Plymouth Rock		Rhode Island Red	
Age	M	F	M	F	M	F
4 wk	0.45	0.42	0.41	0.39	0.41	0.41
8 wk	1.24	1.08	1.22	1.09	1.16	1.07
12 wk	2.20	1.77	2.41	1.93	2.26	1.94

An interesting comparative growth study has been reported by Milby and Henderson (1937). Here the rates of growth for ducks, geese, turkeys and pheasants as well as White Plymouth Rock chickens are compared. The chicken growth data used were originally published by Mitchell, Card and Hamilton (1926). Body weight is the only growth process considered in this paper. Growth curves are presented for all species considered.

Brody (1927) states that growth curves (plotted from his exponential equations) are divided into two principal segments. First, there is a segment of increasing slope in which velocity of growth tends to be proportional to the growth already made. The second portion of the growth line is of a decreased intensity during which the rate of growth tends to be proportional to the final growth yet to be made to reach maturity. He has found the intersection of these segments to occur at puberty in mammals. This apparently does not apply to the different species of birds studied by Milby and Henderson (1937), if we assume that puberty for the class Aves starts with the initiation of egg production.

In analyzing the comparative growth trends Milby and Henderson found that the growth rates of chickens, turkeys, and pheasants are of practically the same magnitude during the first few weeks. During the second period of constant growth the rates were also quite similar excepting that this period was more prolonged for turkeys. Growth rates for pheasants and chickens were almost identical until about the nineteenth week of age. After this time the pheasants ceased growing.

It is interesting to note that the growth curve was practically the same for the two members of the order Anseriformes (ducks and geese). This is quite distinct from the growth curve trends of the three members of the order Galliformes.

Maw (1933) reported rather comprehensive studies which he had made on several pure breeds and crossbreeds. Extensive body measurements were taken among which were length of keel, circumference of body behind the wings, and anterior body depth. In this report no statistical analysis for birds of broiler age was made. The relationship between linear measurements and fleshing (as might be indicated by breast score or weight) was not determined. In the study of the roaster class of fowls no definite indication of a statistical relationship was reported for the linear measurements. Referring to data secured from the roaster stock, Maw does conclude that the deep angular-bodied birds cannot be expected to finish out as first class meat stock. The ten weeks average weight of the Cornish-Barred Plymouth Rock crossbreds was 881.6 grams. The males averaged 936.2 grams and the females 820.5 grams.

A study reported by Lerner, Asmundson and Cruden (1947) presents information of direct interest relating to broiler growth. New Hampshires twelve weeks of age were measured for body weight, shank length, keel length and breast width. While this was primarily a heritability study, the basic growth information presented is quite significant. The length of sternum or keel was measured with calipers. The tarsometatarsus or shank was measured by a special device first described by Burmester and Lerner (1947). The breast width was secured by molding a piece of solder wire over the broiler's breast about one centimeter back of the anterior tip of the sternum. This system of securing breast width is identical in principle and technique to that used by Bennion (1944) in securing breast width data to facilitate turkey selection work.

A high positive correlation was computed for body weight-shank length in the New Hampshires at twelve weeks. This tendency is expected and is presented by Lerner (1939) for a mixed population of fowl using several different age comparisons. In this study, the author points out the tendency for body weight-shank length correlation coefficients to be higher at the same age than when shank length for young birds is compared with body weight for mature fowl. Possibly Jaap and Penquite (1938) explain this correctly by attributing it to differential length of growing period for the whole body beyond the termination of skeletal growth.

The work of Jaap and Penquite (1938) strongly indicates that basic skeletal structure of inter-specific varieties is similar. It would follow then, that any increase in weight for a given shank length would indicate a plumper and more marketable carcass. This observation was reported by Jaap (1938) in turkeys and a study relating shank length to market classes for this bird further supported this fact.

Shank length growth for both the chicken and the turkey is said to cease by the sixth month for the male sex (Jaap, 1938; Jaap, 1949). The growth of this bone for the female stops at least one month earlier. Body growth, when measured by weight increment or keel, continues to the tenth month if not longer.

The shank grows at a more rapid rate than the body as a whole, according to Lerner (1937). Also, in discussing the linear relationship of shank length-body weight as plotted on a log-log grid, he explains the slight flattening of the line at the extreme weight range for females as due to the deposition of fat after cessation of linear growth. This leads us to the conclusion that general body proportions or at least mass-linear relationships are altered near maturity.

In this relation, Lerner (1939) points out the fact that the weight of the breast muscle in relation to the body weight exhibits positive allometry tending toward changing proportions with age. In a mixed population of 590 Barred Plymouth Rocks and crossbreds (Barred Plymouth Rocks crossed with White Leghorns) it was found that the percentage of body weight formed by one side of the large breast muscle varied with age according to the following table.

Age (Weeks	Males	Females
	Per cent	Per cent
4	2.09	2.25
8	2.80	3.53
12	3.48	3.69
16	3.48	3.97
20	3.83	4.08

Of the four major comparisons discussed in the Jaap, Penquite report, the body weight-keel length relationship proved to be the poorest criterion of market quality. General observation indicates that the poorer quality groups in growing turkeys and chickens have proportionally longer keel bones. For a given weight the poorer quality birds, from the market standpoint, usually have grown a longer period of time than the higher quality groups. It is apparently the additional deposits of flesh and fat which make the keel proportionally shorter in the birds exhibiting a higher degree of market acceptability.

Relating the development of the keel or sternum to another order of birds, it is pointed out by Wexelsen (1937) that the length of the sternum is a favorable means of measuring general body growth in the pigeon.

In a report involving individuals of the New Hampshire breed, Buckner, Insko, Henry and Wachs (1948) found the average length of the keel from the keel crest to the end of the metasternum increased about the same to the twentieth week in the male and female. Thereafter, the average length of the keel of the male was greater than that of the female. Calcification to the tip of the metasternum occurred by the fortieth week in all of the chickens examined in their experiment.

In securing breast width measurement Jaap and Penquite (1938) molded wire solder (0.06 inches in diameter) to the breast outline. The anterior point of the keel was used as the ventral point and the wire was then molded to the breast contour with the ends of the wire extending dorsally toward the insertion of the femurs. They found the point one and a half inches (dorsally from the keel line) to be the best measure of breast width. The correlation coefficient at the one and one half inch point between live and dressed birds was 0.80. Live measurements by the wire solder system proved highly accurate in predicting the market conformation group for respective birds.

In Barred Plymouth Rocks and New Hampshires, Jull and Glazener (1946) demonstrated a high positive correlation between body weight and shank length. These birds were ten weeks of age.

Variability in body weight for these varieties was found to be from less than two to more than three times the variability in shank length at ten weeks of age. Variability in growth rate was found to be the greatest at four weeks of age in males. In summarizing their work, the authors infer that probably the most effective selection of birds for breeding purposes to secure differential growth rate in progeny would be on the basis of shank length and body weight at approximately four weeks of age.

The sexual dimorphism reported in the stock used by Jull and Glazener is quite significant. The mean male shank length exceeded the mean female shank length from 8.67 to 11.76 per cent. This may be compared with the mature sex differential for the tarsometatarsus of 20 per cent secured by Latimer (1927). In a study of skeletal differences in the Leghorn fowl, Hutt (1929) reported the shank sex difference for mature birds to be 13 per cent. The figure of 25 per cent reported by Jaap (1938) for mature fowl seems rather large; however, breed and strain differences could very well account for the variation in these reported sex differentials in shank length of mature fowl.

In an analysis of body conformation of the live market turkey, Jaap (1938) made a total of eight separate measurements. These measurements were taken between the twenty-seventh and twenty-eighth week of age. The three which seemed to contribute most to the study were anterior body depth taken from the anterior point of the keel dorsally to the back vertebrae (approximately between the insertion of the femurs), length of keel or sternum and length of tarsometatarsus or shank. Several varieties of turkeys were used including the Bronze, Black, Bourbon Red, Narragansett and White Holland. Jaap reported varietal differences were greatest in proportional length of keel and depth of body. Within the sexes those turkeys with the better fleshing have shorter shanks and thighs in proportion to their body weight. The leg measurement ratio was the best measure used in the study to indicate body fleshing.

Simple correlation coefficients were computed between shank length, anterior body depth and length of sternum. For 630 turkey males the correlation was 0.503 for the keel length-anterior depth. Keel and shank, and depth and shank were not correlated in males. Within the 665 females relatively low but highly significant correlation coefficients were calculated. They were 0.391 for keel length-body depth correlation, 0.376 for body depth-shank length and 0.240 for the keel length-shank length relationship.

In the turkey by the twenty-eighth week, Jaap found that males have a proportionally greater rib spread, back width, anterior body depth and leg length than do females. He concludes that, as they are used in his study, rib spread, back width, median and posterior depth are not suitable for comparing differences in body shape.

Some pertinent work with respect to the present Cornish study has been published by Frischknecht and Jull (1936). In this work the amount of breast meat and the live and dressed grades were related to body measurements in twelve-week old purebred and crossbred broilers. Measurements taken at twelve weeks were weight, body depth, keel length, breast width and shank length plus some other determinations not related to this study. The linear measurements were made with calipers of appropriate size. The breast width was determined by molding a strip of lead across the breast and recording the distance between the points. This system is similar to that used by Asmundson (1944) and Payne (1938) in securing breast width for turkeys. A similar system was also used by Jaap and Penquite (1938).

The analysis of their data indicates that regardless of sex, the larger the bird, the greater is the proportion of breast meat. The correlation coefficient for cut-out breast meat and live weight was 0.93 for males and 0.92 for females. None of the bone measurements appeared to be as highly correlated with the amount of breast meat as was the live body weight. This would tend to support the belief that bone and muscle development are determined, at least in part, by different sets of hereditary factors.

Shank length gave a slightly higher correlation with breast meat than did the other bone measurements. This is not unexpected since shank length is found to be more highly correlated with live body weight than are the other bone measurements. This latter fact is supported by several studies including those of Lerner (1937), Jaap (1938) and Lerner (1939) using different breeds and crosses. This is not necessarilly contradictory to the report of Maw and Maw (1939) who found that an increase in length of leg led to a decrease in the percentage of total edible flesh. However, Jull, Phillips and Williams (1943) do present data from the New Hampshire breed which seems contrary to the findings of Maw and Maw (1939). In a study of the meat contributed by the humeri section of the wings, by the legs and by the breast in relation to shank length, they found the total cut-out meat of these parts, as percentage of total chilled dressed weight, to be greater in their long-shanked group. Further, the greatest difference in favor of the long-shanked birds occurred in the breast meat.

The positive correlation coefficients computed by Frischknecht and Jull for breast meat-shank length were 0.73 for males and 0.82 for females. The breast meat-body depth correlations were 0.77 and 0.65 for males and females respectively. For the breast width-keel length relationship, coefficients of 0.72 for males and 0.82 for females were figured and for breast meat-breast width correlations were 0.58 and 0.66. It should be noted that the breast width determination was actually a poorer measure of the amount of breast meat than any of the other measurements mentioned here.

In considering inter-breed and cross differences in the report, it is significant that the mean live body weights and the mean breast widths were both larger in the progeny of the Cornish-New Hampshire cross than they were in the progeny of either the purebred New Hampshire or the purebred Cornish. This particular cross is becoming a tremendous competitive factor in many broiler areas while the parent breeds, when used as broilers in these areas, are of much less importance economically.

Actual amounts of breast meat on the carcass of Cornish-New Hampshire progeny was found by Frischknecht and Jull to be significantly greater than the amount of breast meat on the carcass of other crossbred and purebred progeny. The comparatively slow growth of the purebred Cornish progeny causes the effects of heterosis in the crossbreds to appear outstanding.

A preliminary report from Hathaway, Champagne and Upp (1949) tends to bear out the higher dressing qualities of the Cornish, even as a purebred, over the other breeds. Rhode Island Red hens and Dark Cornish hens were compared. The following table presents the summarized results:

Breed	Expressed as Percentage of Live Weight N. Y. Dressed	Eviscerated	Deboned
Dark Cornish	93.1	68.8	39.0
R. I. Red	92.5	60.9	37.4

When Frischknecht and Jull correlated the various measurements with the U. S. market grades the following coefficients were calculated.

Measurement X U. S. Market Grade	Correlation-males	Correlation-females
Cross-section breast area	0.87	0.83
Cut-out breast meat	0.80	0.74
Live weight	0.74	0.73
Breast width	0.63	0.76
Body depth	0.56	0.67
Shank length	0.53	0.58
Keel length	0.50	0.62

Crossbreeding, involving the use of a Cornish male with New Hampshire and Barred Plymouth Rock females, produced a higher percentage of grade AA and grade A birds than purebred New Hampshire and Barred Plymouth Rock matings.

The quantitative determination of breast conformation in poultry as presented by Bird (1948) points out several rather significant growth phenomena. These conclusions are based upon a number of measurements taken on both chickens and turkeys. The technique used to determine breast conformation was previously developed by Bird (1945) for progeny testing turkeys on the basis of the measured roundness of the breast. The author points out that while it is characteristic for turkeys to become broader and therefore rounder with increasing depth, the opposite tendency to become narrower as depth increases applies to chickens. He holds that thickness of pectoral masculature and therefore roundness of breast in chickens is separate and independent from width of the thoracic cavity. Data are presented which definitely indicate that roundness of breast in chickens is negatively correlated with the depth of the body. Finally, it is concluded that roundness of breast is inherited chiefly from the male and that its uncomplicated segregation may be expected through the application of such well established methods as the progeny testing system.

With respect to the relationship of body depth to plumpness of body, Jaap, Thompson and Milby (1939) specifically point out that turkeys of superior market qualities have proportionally shorter shanks and proportionally less body depth at all ages measured. This is in direct disagreement with the findings of Bird (1945). Jaap, et al, point out that the quantity of flesh on the breast of the bird is of greatest interest to both seller and buyer. Further, the appearance of this breast area as it appears in the retail center probably has a greater influence upon the marketability of the bird, whether chicken or turkey, than any other body region.

An extensive analysis of body form for growing domestic fowl was reported by Jaap (1941). This work was planned to determine whether measurements of shank length, body depth and keel length when related to the cube root of body weight could be used to detect heritable differences in body structure of live chickens at an early stage of development. The numerical expression of body form was secured by dividing the linear measurement by the cube root of the body weight. This ratio is used by Jaap merely as a simplified index of body form. It has been suggested by Lerner (1939) that the ratio is actually the initial growth index of Huxley and Teissier (1936) and is a selected case of limiting allometry. A total of 1024 chicks were used from two breeds and three crosses. Uniform environmental conditions were maintained as nearly as possible. Jaap observed that male chicks were heavier than their sisters at two weeks of age. Increases in shank length ceased by sixteen to eighteen weeks of age in all female groups with the exception of Light Brahmas.

In crossbreds involving a Cornish parent a statistically significant increase in edible flesh was observed. This is in line with the observations of Maw (1933) for males at twenty-six weeks of age. The males in Jaap's report ranged between eighteen and twenty-seven weeks of age at the time the data were collected. Within each bird the percentage of edible flesh and proportional shank length is not correlated. The author thinks this may be due to a relatively high variability within groups and indicates that the shank length-body shape ratio may not be a satisfactory basis for predicting the percentage of flesh for the individual birds. The inheritance of skeletal structure according to the assumption of Jull, Quinn and Godfrey (1933) is largely independent of fleshing qualities.

In summarizing certain economic trends indicated in his study, Jaap points out that the percentage of edible meat is not necessarily an indication of visual marketability. He believes that a chicken may acquire superior body form in two ways. First, by the increased deposition of flesh and secondly, by basic alteration in the skeletal structure. It apparently has been impossible to distinguish between birds attaining a plump body through additional fleshing and those with such skeletal structure as to make the body appear plump. His work indicates that the Cornish is a breed possessing both characteristics plus the capacity to transmit those traits to its progeny.

The two Cornish crosses used were Dark Cornish males on White Plymouth Rock females and Dark Cornish males on White Leghorn females.

In an early study of relative growth in the domestic fowl, Lerner (1937) presented data supporting the possibility that growth of Bantams might not be similar to the growth characteristics for larger breeds. In a later study, however, Lerner (1941) has concluded that the constants for relative growth of the large breast muscle (pectoralis major), the femur, the tibiotarsus and the tarsometatarsus in Rose Comb Black Bantams (American Poultry Association, 1938) are of the same magnitude as in Leghorns and other breeds previously studied. This conclusion was reached after he had segregated variation due to growth from that due to variation in body proportions at maturity.

In his conclusion Lerner points out that the growth ratios of the breast muscle and the leg bones, with respect to body weight of Bantams, do not differ from those of Leghorns and are remarkably close to those previously reported for Barred Plymouth Rocks, Minorcas and their crosses.

In considering relative growth of the leg bones, towards the end of the growth period the tarsometatarsus, because of its higher growth rate, exceeds the femur in length. At two weeks of age, however, the femur is still the longer of these two bones.

Summarily, it appears then that tachyauxesis (Needham and Lerner, 1940), is demonstrated for the structures studied in the Bantam as well as in breeds of larger size. The uniformity of the morphogenetic plan of growth in the different breeds of chickens is confirmed with the added fact that Bantams also adhere to the same development pattern.

Since it is known that body form of Dark Cornish Bantams differs from that of the Rose Comb Black Bantam, Jaap, Penquite and Thompson (1944) sought a comparison of the former breed with normal-sized White Wyandottes. The growth and changes in proportion of the body and shank of 75 Dark Cornish Bantams and 89 White Wyandottes were compared during the first twenty to twenty-four weeks after hatching. The shank length of the Bantams was proportionally shorter than that of the Wyandottes during the entire period of study. The changes in proportions with increasing size were identical during the first two to three months after hatching. During this period the shank grew more rapidly than the body as a whole. Following the period of more rapid relative growth-rate the shank was depressed prior to its attainment of complete maturity. This made relative growth of the Bantams more like that of the Wyandottes at the same age than at the same size.

Jaap points out that growth comparisons between Bantams and Wyandottes would indicate that much of the variation in body proportions is the result of variation in general body growth according to age. A large part of the variation in body form may be directly related to the percentage of the inherited size-limitation attained within specific time periods. This presupposes the fact that the genes controlling growth are not the same as those which control mature size.

This latter hypothesis is supported by Hammonds, et al, (1940) in their work with domestic mammals. By varying the food intake at distinct periods during the growth process these workers have been able to vary the relative proportions of bone, flesh and fat, thereby changing the body conformation. They suggest that differences in body proportions found between unimproved and improved meat breeds are due to genetic factors which regulate the relative growth of parts during distinct periods of development and growth. They theorize that in the improved animal, genetic factors cause a more rapid increase in flesh and fat earlier in the growth period of the animal.

RESULTS AND DISCUSSION

The various means for weight, shank length, anterior body depth, keel length, and breast width are presented in Tables I and II. These data are also graphically presented in Figures 1 through 10. Table I presents the means for the 175 males and 179 females which were measured through twelve weeks . Table II presents the means as secured for the 101 males and 96 females, measured at four-week intervals through twenty-eight weeks. These data give us a numerical conception of the average growth progression for the different growth criteria.

The growth curves for both sexes through the twelve-week and twenty-eight—week periods are presented in Figure 1. The nature of the weight differential for the sexes is apparent here throughout their growth period. The mean day-old weights (Table I) are small owing to the relatively small eggs from which they were hatched. The average weight of these eggs was about 21.5 ounces per dozen. Normally, broiler chicks are hatched from eggs averaging approximately 24 ounces per dozen. It will also be noted that the growth rate for this stock is slow compared to the average commercial broiler stock. This Cornish stock averaged 1137.1 grams for both sexes at twelve weeks. This may be compared with the unofficial ten weeks average of 1380.0 grams for the 1951 National Chicken-Of-Tomorrow Contest. The growth weight attained by the Cornish, however, is believed to be representative of the breed. The males were significantly heavier than the females by the end of the first week of age (Table X) and this sex differential was highly significant after three weeks growth.

Tables I and II also present the standard deviations and the coefficients of variability for the gross data secured from all measurements. Table I indicates that for male weights these two statistics attain their greatest variability at the third week, being 24.26 and 13.35 respectively. Table II bears out this trend with the coefficient of variation of 14.03 for the fourth week.

The standard deviation is an average of the variation existing in the data. It is a typical deviation in much the same way that the mean is a typical observation. In general this statistic for the work reported is well within reason, varying from 9.8 per cent to 13.35 per cent of the mean weights (Table I), and is a fair commendation for the technique used.

The coefficient of variation is presented to give an estimate of the relative variation. It is pointed out by Snedecor (1946) that a knowledge of relative variance is useful in planning and in evaluating experiments. For example, in corn variety trials the same mean yield and standard

Table I. Variability of Measurements, 175 Males-179 Females
(Weight given in grams, other measurements given in centimeters.)

	Males				Females		
	Mean	Std. Dev.	Coef. Var.		Mean	Std. Dev.	Coef. Var.
				1*st Day*			
Weight	31.7	3.110	9.80		31.2	2.810	8.99
Shank	2.6	.084	3.28		2.5	.084	3.32
				1*st Week*			
Weight	61.2	7.510	12.27		59.6	6.980	11.71
Shank	3.1	.146	4.66		3.1	.151	4.92
Depth	2.9	.170	5.88		2.9	.160	5.55
				2*nd Week*			
Weight	107.4	13.480	12.55		103.5	11.860	11.46
Shank	3.8	.186	4.88		3.7	.201	5.39
Depth	3.8	.207	5.40		3.8	.206	5.42
				3*rd Week*			
Weight	181.7	24.260	13.35		174.2	20.650	11.85
Shank	4.7	.242	5.19		4.5	.263	5.79
Depth	4.8	.248	5.22		4.7	.261	5.56
				4*th Week*			
Weight	268.8	34.510	12.84		251.8	29.450	11.69
Shank	5.3	.271	5.07		5.2	.289	5.57
Depth	5.8	.296	5.12		5.7	.315	5.54
Keel	5.2	.259	5.01		5.1	.246	4.79
Breast	1.7	.110	6.57		1.7	.102	6.16
				5*th Week*			
Weight	348.2	43.130	12.39		319.8	38.100	11.91
Shank	6.0	.291	4.87		5.8	.306	5.31
Depth	6.4	.305	4.77		6.2	.337	5.43
				6*th Week*			
Weight	468.4	57.900	12.36		419.0	51.520	12.30
Shank	6.7	.330	4.92		6.4	.353	5.52
Depth	7.0	.349	4.98		6.8	.348	5.12
				7*th Week*			
Weight	606.3	72.940	12.03		534.1	62.350	11.67
Shank	7.3	.380	5.19		6.9	.372	5.36
Depth	7.6	.379	4.97		7.4	.375	5.09
				8*th Week*			
Weight	718.0	85.310	11.88		618.1	74.340	12.03
Shank	8.0	.363	4.51		7.5	.413	5.48
Depth	8.3	.395	4.75		7.9	.390	4.92
Keel	7.7	.386	4.99		7.4	.345	4.64
Breast	2.4	.170	7.23		2.3	.154	6.64
				9*th Week*			
Weight	890.3	83.080	9.33		746.2	85.270	11.43
Shank	8.6	.405	4.70		8.0	.417	5.20
Depth	8.9	.407	4.58		8.4	.398	4.73
				10*th Week*			
Weight	1040.7	117.230	11.26		862.0	96.540	11.20
Shank	9.2	.420	4.57		8.4	.435	5.15
Depth	9.4	.462	4.90		8.9	.438	4.91
				11*th Week*			
Weight	1139.9	131.810	11.56		927.0	106.070	11.44
Shank	9.7	.466	4.83		8.8	.475	5.43
Depth	10.0	.489	4.90		9.4	.447	4.77
				12*th Week*			
Weight	1259.6	138.720	11.01		1014.8	113.950	11.23
Shank	10.2	.465	4.56		9.1	.484	5.29
Depth	10.4	.494	4.74		9.8	.472	4.84
Keel	9.6	.464	4.84		9.0	.438	4.89
Breast	2.9	.227	7.74		2.8	.199	7.06

deviation vary with location and season, yet the coefficient of variation is often between 5 and 15 per cent. When values fall outside of this interval the experimenter has cause to wonder if error has occurred in calculation, or if some unusual circumstances throw doubt on the validity of the trial.

The various experimental animals have their own characteristic coefficients of variation. These may be compared despite the diversity of

Table II. Variability of Measurements, 101 Males-96 Females
(Weight given in grams, other measurements given in centimeters.)

	Males			Females		
	Mean	Std. Dev.	Coef. Var.	Mean	Std. Dev.	Coef. Var.
1st Day						
Weight	31.7	3.200	10.08	31.5	2.670	8.48
Shank	2.6	.082	3.21	2.5	.085	3.35
4th Week						
Weight	267.9	37.600	14.03	255.2	29.890	11.71
Shank	5.4	.298	5.57	5.3	.348	6.63
Depth	5.8	.308	5.32	5.7	.261	4.57
Keel	5.2	.274	5.31	5.0	.200	4.36
Breast	1.7	.114	6.78	1.6	.095	5.90
8th Week						
Weight	722.0	91.200	12.63	630.4	74.840	11.87
Shank	8.1	.423	5.25	7.6	.369	4.84
Depth	8.3	.410	4.92	8.0	.353	4.42
Keel	7.7	.385	4.98	7.3	.433	5.91
Breast	2.4	.166	7.03	2.3	.145	6.42
12th Week						
Weight	1268.4	144.460	11.39	1033.9	113.030	10.93
Shank	10.2	.451	4.43	9.2	.429	4.65
Depth	10.5	.488	4.66	9.8	.422	4.29
Keel	9.6	.465	4.84	9.0	.415	4.59
Breast	2.9	.225	7.68	2.8	.187	6.68
16th Week						
Weight	1725.3	195.250	11.32	1300.9	137.090	10.54
Shank	1140.4	.559	4.90	9.7	.496	5.10
Depth	11.7	.517	4.40	10.8	.482	4.48
Keel	10.8	.519	4.83	9.9	.472	4.76
Breast	3.3	.237	7.22	3.2	.222	7.02
20th Week						
Weight	2068,1	223.460	10.80	1570.2	204.220	13.01
Shank	11.9	.596	5.03	9.8	.486	4.94
Depth	12.4	.579	4.66	11.1	.510	4.61
Keel	11.7	.567	4.85	10.6	.508	4.78
Breast	3.6	.278	7.72	3.6	.239	6.56
24th Week						
Weight	2352.4	247.780	10.53	1854.0	210.900	11.37
Shank	11.9	.626	5.25	9.8	.506	5.16
Depth	12.5	.544	4.34	11.2	.526	4.68
Keel	12.3	.556	4.52	11.1	.501	4.52
Breast	4.0	.277	7.01	3.9	.255	6.52
28th Week						
Weight	2496.1	210.550	8.43	1899.6	241.920	13.26
Shank	12.0	.609	5.09	9.8	.503	5.12
Depth	12.8	.594	4.63	11.4	.527	4.63
Keel	12.6	.612	4.85	11.0	.563	5.11
Breast	4.2	.406	9.69	3.9	.300	7.65

the variable measured. For example, body weight for male albino rats between 90 and 243 days of age has an average coefficient of variability of about 14 per cent. For annual egg production of Barred Plymouth Rock hens it is close to 32 per cent. Such information is essential for those planning and supervising experimental work.

From a review of Tables I and II, we can draw reasonably valid conclusions as to the coefficients of variation one could expect for the five

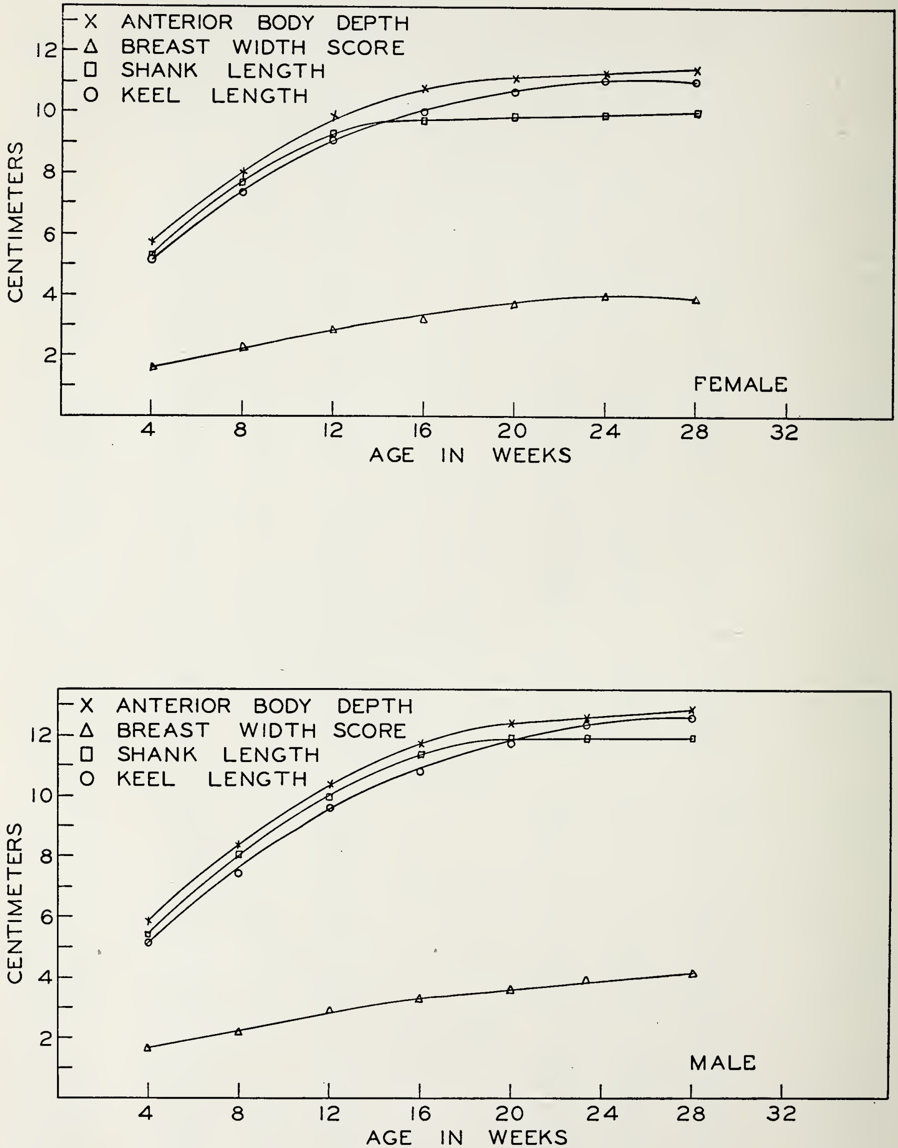

Figure 1. Growth progression curves for twenty-eight weeks, four criteria considered.

different criteria of growth studied. For example, we note from Table II that the coefficients of variation for male shank length ranges from 3.21 for day-old chicks to a high of 5.57 for the fourth week. It may be of interest to note that this statistic was at its greatest magnitude for males, for all criteria excepting breast score, at the fourth week. This trend is not noted for the females at four weeks in Table II. Table I accentuates the greater variability of the males at the third and fourth

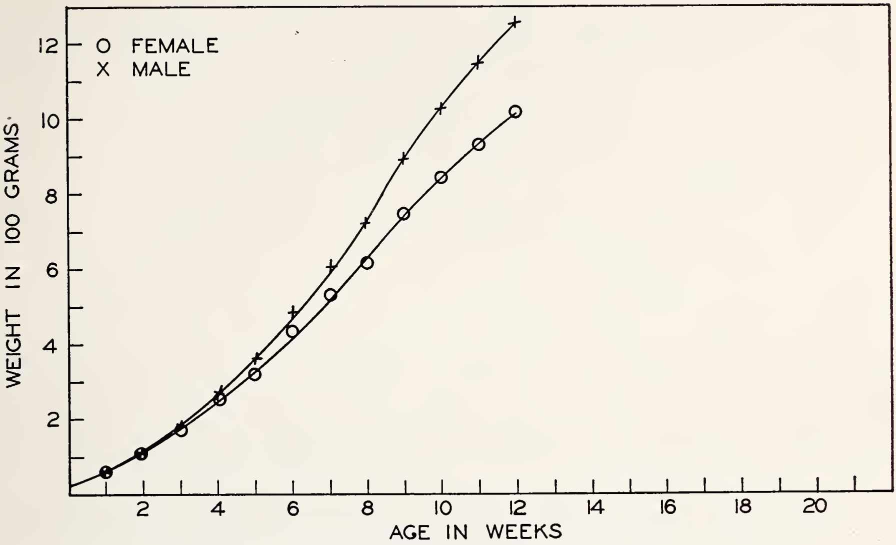

Figure 2. Growth progression, weight only, considered for twelve weeks.

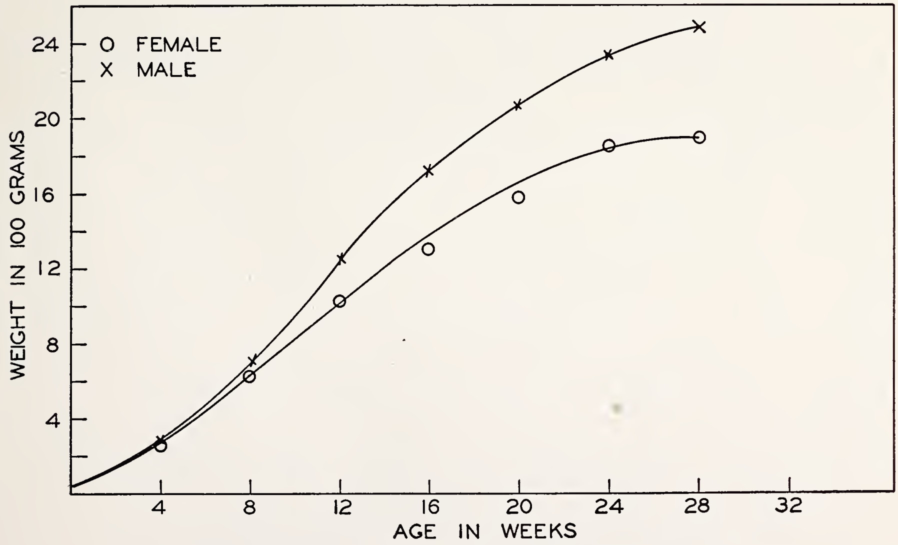

Figure 3. Weight curves for both sexes through twenty-eight weeks.

weeks. We have no explanation for this phenomenon other than the fact that, as shown in Table X, the growth difference between sexes is becoming significant and highly significant about this time.

A comparison of the coefficients of variability for the five growth criteria studied seems to indicate that the figures for shank length, anterior body depth and keel length are practically the same, approximately 5 per cent, with no apparent sex difference. This holds true for both Tables I and II. On the other hand, the coefficient of variability for breast score is slightly but consistently greater. The range for males, Table II, is from the low of 6.78 at four weeks to the high of 9.69 at twenty-eight weeks. It may be noted that in every instance in both

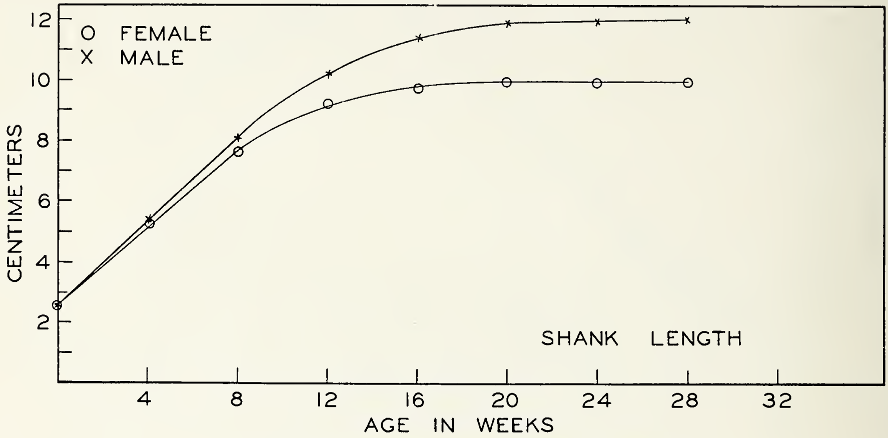

Figure 4. Sex differential in shank length.

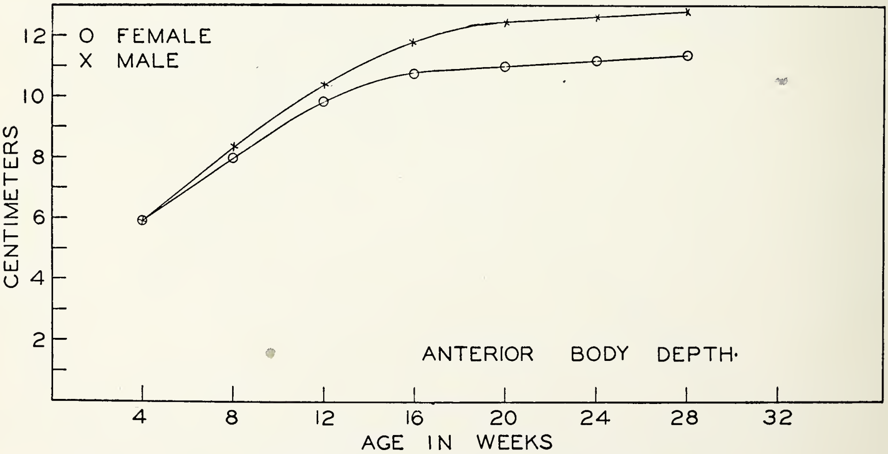

Figure 5. Sex differential for anterior body depth.

Tables I and II this statistic was highest in case of the males. This holds true for all criteria and may be attributed to the characteristic sex differential.

The linear increment for shank, depth and keel measurements for the twenty-eight weeks is presented in Table II. The mean shank length for day-old males is 2.55 centimeters and at maturity the length is

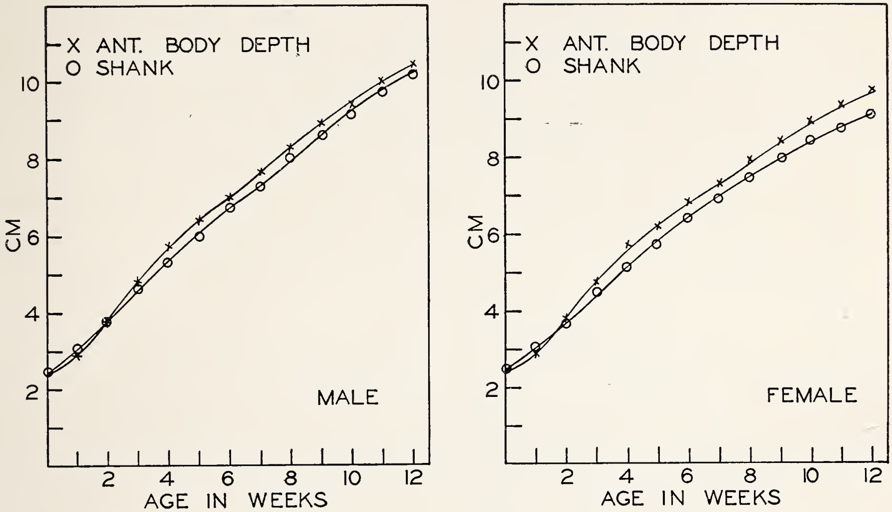

Figure 6. Comparative growth of anterior body depth and shank for twelve weeks, both sexes.

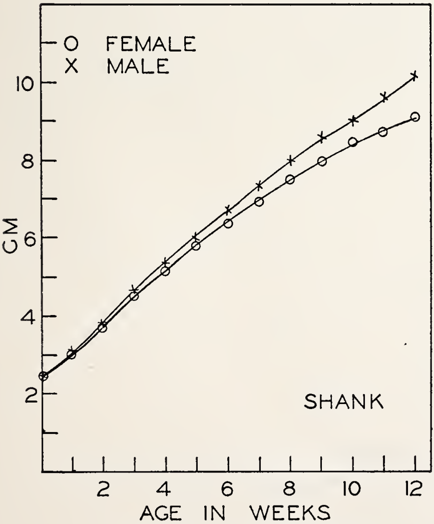

Figure 7. Sex differential for shank length.

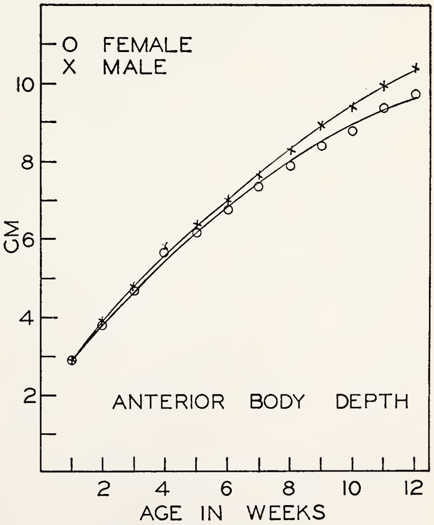

Figure 8. Sex differential for anterior body depth.

11.97 centimeters. The rate of linear growth is quite similar for all three of these criteria. Figure 1, however, clearly indicates that the growth of the tarsometatarsus (shank length) tends to level off before maximum body depth and keel length are attained. This growth attainment for shank is reached at about the eighteenth week in case of the male and at about the fourteenth week for the female. This is in agreement with Jaap (1941).

The correlation coefficients for the five growth processes are presented in Tables III and IV. These range from strong correlations of about 0.9 in some instances to nearly significant negative correlations approaching -0.2. These data may be noted to run fairly uniform when the same age and measurements are compared for the two tables. Also,

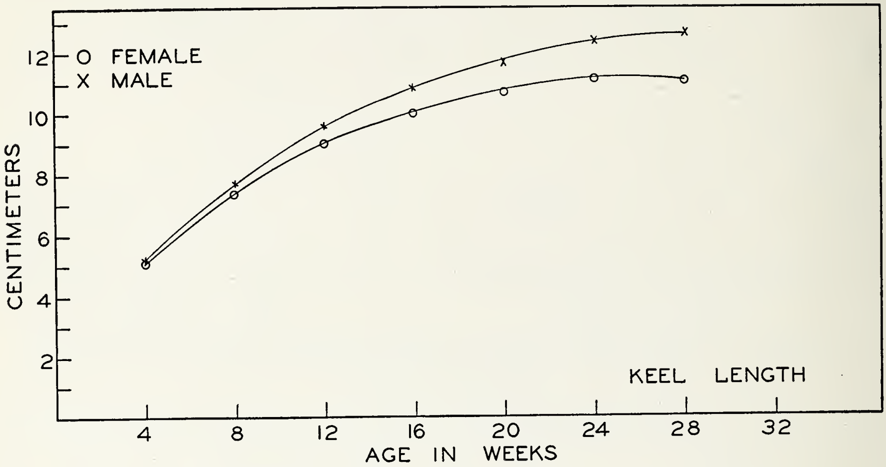

Figure 9. Sex differential for keel length through twenty-eight weeks.

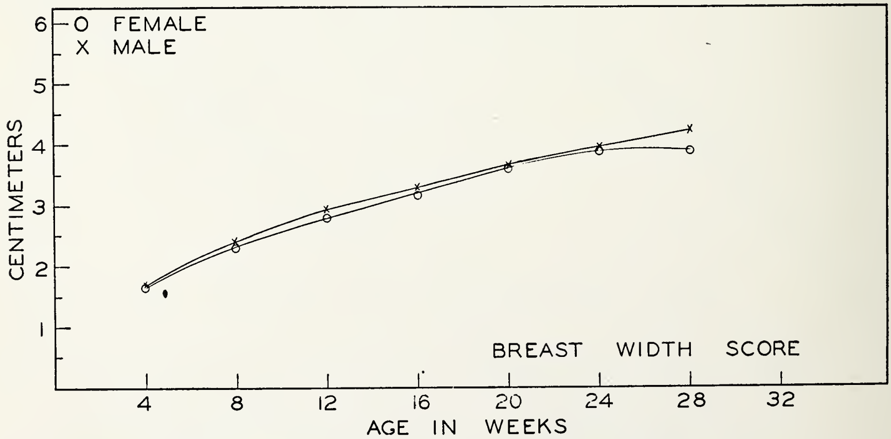

Figure 10. Sex differential in breast width score through twenty-eight weeks.

Table III. Correlation Coefficients, 175 Males-179 Females
(Coefficients less than 0.138 are not significant at the 5% level.)

	1st Week		2nd Week		3rd Week		4th Week		5th Week		6th Week	
	M	F	M	F	M	F	M	F	M	F	M	F
Weight x Shank*	.766	.783	.749	.804	.872	.788	.675	.659	.825	.752	.827	.812
Weight x Depth	.607	.626	.779	.779	.834	.769	.742	.680	.791	.752	.746	.757
Weight x Keel							.814	.660				
Weight x Breast							.463	.265				
Shank x Depth	.652	.688	.780	.765	.835	.850	.669	.691	.757	.736	.820	.798
Shank x Keel							.692	.598				
Shank x Breast							.431	.123				
Depth x Keel							.651	.643				
Depth x Breast							.264	.109				
Keel x Breast							.325	.151				

	7th Week		8th Week		9th Week		10th Week		11th week		12th Week	
	M	F	M	F	M	F	M	F	M	F	M	F
Weight x Shank	.794	.751	.866	.784	.853	.798	.777	.793	.781	.783	.722	.755
Weight x Depth	.795	.751	.726	.726	.890	.747	.752	.774	.504	.748	.760	.758
Weight x Keel			.698	.696							.662	.697
Weight x Breast			.265	.169							.335	.251
Shank x Depth	.769	.790	.867	.824	.700	.834	.804	.832	.812	.804	.821	.606
Shank x Keel			.710	.643							.628	.607
Shank x Breast			.184	−.049							.016	−.053
Depth x Keel			.700	.666							.670	.724
Depth x Breast			−.071	−.151							−.014	−.133
Keel x Breast			.065	−.166							−.090	−.186

*Weight x Shank, first day: males, .302; females, .207.

Table IV. Correlation Coefficients, 101 Males-96 Females
(Coefficients less than 0.195 are not significant at the 5% level.)

	4th Week	8th Week	12th Week	16th Week	20th Week	24th Week	28th Week
			Males				
Weight x Shank*	.757	.793	.757	.649	.603	.636	.836
Weight x Depth	.739	.756	.721	.739	.702	.658	.818
Weight x Keel	.801	.758	.744	.735	.732	.684	.814
Weight x Breast	.518	.362	.393	.360	.380	.273	.141
Shank x Depth	.543	.807	.835	.753	.695	.706	.739
Shank x Keel	.733	.735	.701	.619	.521	.534	.563
Shank x Breast	.442	.267	.092	−.090	−.138	−.157	−.089
Depth x Keel	.734	.732	.724	.647	.520	.505	.460
Depth x Breast	.299	.043	.102	.088	−.053	−.017	−.078
Keel x Breast	.373	.053	−.017	.034	.008	−.113	−.048

	4th Week	8th Week	12th Week	16th Week	20th Week	24th Week	28th Week
			Females				
Weight x Shank*	.507	.751	.726	.615	.545	.647	.697
Weight x Depth	.680	.759	.578	.766	.561	.708	.755
Weight x Keel	.698	.583	.728	.719	.629	.697	.682
Weight x Breast	.264	.060	.260	.252	.152	.249	.307
Shank x Depth	.469	.834	.791	.741	.791	.764	.829
Shank x Keel	.455	.551	.667	.521	.547	.664	.603
Shank x Breast	.073	−.191	−.124	−.130	−.140	−.055	.095
Depth x Keel	.522	.553	.707	.626	.568	.521	.602
Depth x Breast	.046	−.231	−.144	−.093	−.186	−.078	−.065
Keel x Breast	.195	−.140	−.127	−.118	−.194	−.103	.040

*Weight x shank, first day: males, .325; females, .327.

in a general way the correlations for the same measurements tend to remain similar for the sexes. It is true that sex differences do show up in these data. For example in Table III, the correlation of keel x breast at the fourth week for males shows a significant positive figure of 0.325. The 0.151 correlation for the females is not significant for the numbers used.

It is pointed out by Snedecor (1946) that perfect correlation ($r = 1$) rarely occurs in biological data. Each field of investigation has its own range of coefficients. The English workers Pearson and Lee (1902-1903), for example, secured values for height and width in humans ranging from 0.60 to 0.83. A correlation of 0.986 has been published for live weight and warm dressed weight of swine.

It is apparent then that judgment concerning the size of a correlation should be weighted with similar correlations encountered in the same field under similar conditions.

The correlations calculated in this Dark Cornish study which are comparable to the coefficients computed from the measurements of Lerner, Asmundson and Cruden (1947) compare quite favorably. However, since these workers consider only the one age for the New Hampshires, that being twelve weeks, the developmental trend is not evident. The fact that the weight-breast width correlation was found to be lower for the New Hampshire than for the Cornish is attributed to a breed difference. The only negative correlation observed by Lerner, et al, for the New Hampshires was between keel length and breast width. This figure amounted to -0.070, which was actually a smaller negative number than that secured for this Cornish study (-0.107 for males and -0.127 for females). This indicates the difficulty that the breeder would likely encounter in selecting for both of these criteria in the same stock. The economic value of having both length and width of breast in poultry meat stock should encourage geneticists in this field to seek means of overcoming this obstacle.

It is notable from Tables III and IV that one of the consistently high correlations obtained is for body weight and shank length. The relationship attains statistical significance after one week's growth for both sexes (Table III), 0.766 for males and 0.783 for females. For the first twelve weeks growth (Table III) it is highest for males at the eighth week, 0.866, and for females at the sixth week, 0.812. This statistic remains significant for both sexes throughout the twenty-eight weeks growth and is fairly constant throughout the period for both sexes. These data agree with Lerner (1937) who reported a correlation of +0.659 for the same criteria at twelve weeks. Our figures for this age (Table III) are 0.722 for males and 0.755 for females.

From Table IV it would seem that the weight-shank length correlation is more definitely positive in males than in females. For example, at all measurement periods with the exception of the twenty-fourth week, the calculated figure is greater for males than for females.

At the twenty-fourth week the weight-shank length male correlation was 0.636 and the female figure was 0.647. There is probably no real difference in this case.

In general, the work of Jull and Glazener (1946) is supported by the findings of this study since they secured high positive correlations for body weight-shank length. Most of their correlations was near 0.7. This is for birds ten weeks of age and without specific reference to sex.

The correlations obtained for body weight-body depth are not significantly different from those secured for weight-shank. In Table IV, for instance, the fourth week male correlation for weight-shank is 0.757 and for weight-depth it is 0.739. At the twenty-eighth week the male figure for weight-shank is 0.836 and for weight-depth it is 0.818. It is noted that approximately 60 per cent of the variation within this relationship is accounted for by these values. This assumption is based upon calculation of the coefficient of determination which is *r* squared. This associates a percentage of the variability in one criteria with a like percentage of variability in the other criteria. There seems to be no real sex difference indicated here.

The correlation for body weight and keel length is apparently of the same magnitude as found for weight-shank and weight-depth, that is, about 0.7. In this case as with the weight-shank relationship there seems to be a slightly higher positive correlation for the males than for the females. The fourth week figure for males (Table IV) is 0.801 and for females 0.698. At the twenty-eighth week the male correlation for weight-keel is 0.814 and for the females the correlation is 0.682. This remarkable similarity is at least an indication that the sex influence has been rather constant throughout the maturing process. The only exception to this trend occurs at the twenty-fourth week. This was also the only period at which the body weight-shank length correlation for males was less than that found for the females. This may indicate a similarity in the growth progression for the shank (tarsometatarsus) and the keel (sternum). It is a fact, however, that while the tarsometatarsus is a long bone with the growth characteristics of such, the sternum has neither the morphology nor the function of a long bone.

The correlation for body weight and breast width as presented in Table IV reveals a consistently low positive association ranging from a significant 0.518 for four-week males to a non-significant 0.141 for twenty-eight week old males. It is noted here that the trend is for the weight-breast width correlation to decrease in the males as they mature. This relationship for the females seems relatively constant and only barely significant in most cases. There seems to be no particular trend with the onset of maturity. The relationship is constantly positive, however, so that one must recognize the association. In the selection of breeders for a fuller, more meaty breast the geneticist probably should give body weight some consideration. This is in agreement with Lerner (1939). The sex differential in this case is definitely in favor of a higher male correlation until the twenty-eighth week. For example, the male correlation at twenty weeks of age is 0.380 while the correlation for the same age females is 0.152.

The very low correlation secured for eight-week females, 0.060, (Table IV) was recalculated several times by different operators. Although it is not in line with other data it is accurate insofar as these data are concerned. No explanation is offered for this deviating figure.

As might be expected from the relatively strong correlations for weight-shank and weight-depth, the correlation for shank length and body depth is consistently high and positive with not much difference from the eighth week through the twenty-eighth week, as indicated by the low and high extremes of 0.695 and 0.835 respectively. This relationship has the highest average correlation for both sexes of any similar coefficient calculated. There was a consistent tendency after the sixteenth week for the female correlation to exceed that of the male. The validity of this trend cannot be determined from these data.

These relatively high correlations for shank length and body depth are not in agreement with the same type of correlations secured by Jaap (1938) with twenty-eight week old turkeys. For 630 turkey males he found no correlation between shank length and body depth. However, in the same trial using 665 females he secured a highly significant correlation of 0.376 for these criteria. The shank-depth correlations calculated in this Cornish study for twenty-eighth week males was 0.739 and for the females 0.829. Both of these figures are highly significant.

While our correlations for shank length are somewhat lower than those found for shank-depth they are still significant for both sexes. Jaap did not find a positive correlation in his turkey males for these criteria; however, this growth relationship for turkey females was highly significant at 0.240. This compares with 0.563 for males and 0.603 for females of the same age for the Cornish fowl in the present study.

A study of the shank length-breast width correlations (Table IV) reveals that the only positive correlations were for the male chicks at the fourth and eighth weeks. It can be noted that the correlations for the males have a greater positive tendency than do the correlations calculated for the females. This is true until the twentieth week, after which the tendency is reversed. It may be postulated that this latter trend is due to the increased sex differential attained near maturity.

The correlation values for both males and females for body depth and keel length are positive and significant throughout the growth period. Jaap (1938) also found these measurements to be correlated in his turkey work. For twenty-eight week old males he calculated a highly significant 0.503, and for the turkey females the relationship was 0.391. This compares with correlations of 0.460 and 0.602 for Cornish males and females respectively. The sex differential tendency for these measurements is constant and interesting. The males present the higher positive correlation early in the growth period. This differential di-

Table V. Inter-Age Correlation Coefficients, 101 Males-96 Females

	4th Week x 12th Week	4th Week x 12th Week	4th Week x 28th Week	4th Week x 28th Week	12th Week x 28th Week	12th Week x 28th Week
	M	F	M	F	M	F
Weight x Weight	.751	.782	.715	.502	.971	.701
Weight x Shank	.597	.544	.239	.203	.386	.396
Weight x Depth	.578	.514	.181	.369	.355	.540
Weight x Keel	.582	.571	.333	.309	.451	.450
Weight x Breast	.427	.227	.264	.089	.256	.077
Shank x Shank	.730	.507	.509	.310	.808	.860
Shank x Depth	.623	.426	.395	.308	.617	.805
Shank x Keel	.547	.369	.352	.235	.529	.621
Shank x Breast	.231	–.061	.175	–.152	.108	–.128
Depth x Depth	.590	.528	.395	.567	.682	.718
Depth x Keel	.497	.400	.389	.338	.521	.523
Depth x Breast	.111	–.103	.035	–.079	.104	–.206
Keel x Keel	.768	.689	.571	.393	.793	.661
Keel x Breast	.236	–.033	.145	–.139	.100	–.168
Breast x Breast	.574	.406	.225	.311	.479	.579

minishes through the sixteenth week, at which time the tendency is reversed. From the sixteenth through the twenty-eighth week the positive difference in favor of the female is increased. This may be a true sex differential becoming apparent at the onset of maturity.

A general consideration of the calculated coefficients for body depth and breast width indicates that these measurements are not correlated. The same apparently is true for the keel length-breast width relationship. These relationships may be exemplified by the depth-breast calculations for sixteen-week-old males of +0.088 and females −0.093. The correlations for keel length-breast width twenty-eight weeks was −0.048 for males and +0.040 for females.

The inter-age correlations for all measurements as calculated for the more critical ages, from a bio-economic standpoint, are presented in Table V. In general, the tendency is for the coefficients to become less significant as the age interval increases. For example, the weight x weight figure for the period, fourth week x twelfth week, males, was 0.751. This was reduced to 0.715 when considering fourth week x twenty-eighth week. The reduction in magnitude of the coefficient is even greater for weight x shank and weight x depth when the age interval is projected from fourth x twelfth week to fourth x twenty-eighth week. A review of the literature did not disclose comparable data with which we could make a comparison.

Generally, the coefficients for males are higher than those calculated for the females for the fourth week x twelfth week and the fourth week x twenty-eighth week. An example of this is seen in the shank x shank comparison. For the fourth x twelfth week the figure for males is 0.730 and for the female is 0.507. For the same criteria, the fourth x twenty-eighth week coefficients for males was 0.509 and for females 0.310. This trend is much less apparent in the twelfth week x twenty-eighth week comparisons. For the shank x shank study during the above period the females actually had the higher correlation, 0.860 compared to the male figure 0.808. This may be due to the fact that the female reaches physical maturity, especially with reference to the length of the long bones, several weeks ahead of the male (Jaap, 1949).

It is also of interest that there exists a significant and highly consistent sex difference for each inter-age correlation involving body weight x breast width, shank length x breast width and keel length x breast width. It is notable that in every case mentioned above, and in each inter-age comparison, the male coefficient has greater positive magnitude than that found for the female. No hypothesis is proposed to explain why these predictive values should show such a consistent difference for the sexes.

Several practical applications might very well be made from this table using certain relatively high inter-age correlations, at the twelve week x twenty-eight week period, for predicting future conformation. It seems that breeding stock might be selected at the twelfth week for such criteria as body weight, shank length and keel length, with a relatively high degree of accuracy. This conclusion is premised on the comparatively high coefficients secured for the above criteria at the twelve week x twenty-eight week comparison. Selection for body depth and breast width might also be ventured at this time. The predictive values here, however, indicate the possibility for greater error with less of the variability being accounted for. The elimination of undesirable breeder types at twelve weeks of age would be of considerable economic significance. The added expense of rearing any questionable individuals to maturity might be saved. Also, their comparative market price would be greater at the broiler age ten to twelve weeks) than later. In addition, by exerting greater selection pressure at the twelve-week level a greater number of individuals could be reared to that age. This should allow a sharp increase in selection pressure and further advance progress to a more favorable genotype.

Table VI sets out the intra-age multiple correlation coefficients for the ages and criteria felt to be most significant and of greatest economic importance. It is evident from these data that the ability to predict a character is not greatly improved by the consideration of an additional measurement. The values were increased somewhat; for example, Table IV shows weight x breast correlation for twelve-week males to be +0.39. When shank length is used together with body weight to predict breast score the value is +0.50 for the twelve-week-old males. The inclusion of body depth in the shank x weight correlation gives practically no increase in positive values. For instance, the twelve-week weight x shank figure for females (Table IV) is 0.726. When body depth is included to calculate the intra-age multiple correlation coefficient the result is still 0.72. Based upon this study, a comparison of the other multiple correlation values with those for simple correlations indicates that the multiple consideraion is of highly questionable utility.

Inter-age multiple correlation coefficients were calculated considering the more economically important ages and measurements. It was thought that by using two measurements to predict a third it might be possible to predict phenotype more accurately. These data, as presented in Table VII, may be compared with the simple inter-age correlation coefficents as set out in Table V. For example, the twelve week x twenty-

Table VI. Inter-Age Multiple Correlation Coefficients, 101 Males-96 Females

	12 Week	12 Week	28 Week	28 Week
	M	F	M	F
Weight x Shank - - Breast	.50	.52	.40	.41
Weight x Depth - - Breast	.47	.51	.38	.39
Weight x Keel - - Breast	.48	.52	.31	.42
Shank x Depth - - Weight	.77	.72	.88	.76
Shank x Keel - - Weight	.81	.79	.93	.77
Depth x Keel - - Weight	.78	.73	.95	.80

Table VII. Inter-Age Multiple Correlation Coefficients, 101 Males-96 Females

4th Week		12th Week		4th Week		28th Week		12th Week		28th Week	
					MALES						
Weight x Shank	— —	Breast	.45	Weight x Shank	— —	Breast	.27	Weight x Shank	— —	Breast	.29
Weight x Depth	— —	Breast	.52	Weight x Depth	— —	Breast	.26	Weight x Depth	— —	Breast	.28
Weight x Keel	— —	Breast	.46	Weight x Keel	— —	Breast	.27	Weight x Keel	— —	Breast	.29
Shank x Depth	— —	Weight	.67	Shank x Depth	— —	Weight	.25	Shank x Depth	— —	Weight	.36
Shank x Keel	— —	Weight	.63	Shank x Keel	— —	Weight	.33	Shank x Keel	— —	Weight	.40
Depth x Keel	— —	Weight	.62	Depth x Keel	— —	Weight	.35	Depth x Keel	— —	Weight	.45
					FEMALES						
Weight x Shank	— —	Breast	.24	Weight x Shank	— —	Breast	.18	Weight x Shank	— —	Breast	.19
Weight x Depth	— —	Breast	.24	Weight x Depth	— —	Breast	.10	Weight x Depth	— —	Breast	.21
Weight x Keel	— —	Breast	.28	Weight x Keel	— —	Breast	.14	Weight x Keel	— —	Breast	.18
Shank x Depth	— —	Weight	.62	Shank x Depth	— —	Weight	.37	Shank x Depth	— —	Weight	.54
Shank x Keel	— —	Weight	.65	Shank x Keel	— —	Weight	.32	Shank x Keel	— —	Weight	.47
Depth x Keel	— —	Weight	.63	Depth x Keel	— —	Weight	.49	Depth x Keel	— —	Weight	.57

eighth week, weight x breast correlation for males (Table V) is 0.256. In Table VII for the same age males the weight x keel x breast figure is 0.29. Here the addition of the keel criteria seemed to be of slight value. Again, comparing the weight x breast correlation for females, fourth week x twelfth week period (Table V) the value is 0.227. When weight x shank is used to predict breast score the value is only 0.24, and the substitution of keel length for shank length increases the value to 0.28. It will be noted that the incremental value due to the multiple consideration is very slight. In a few instances the predictive value is actually reduced slightly by the multiple correlation procedure. This is exemplified in Table V, where the twelve week x twenty-eight week correlation for weight x keel, males, is 0.451. When shank x keel are used to predict weight the value is calculated to be 0.40. It is concluded that, for practical purposes, the value of an additional growth criterion to increase the ability to select future breeders is questionable.

It is pointed out by Snedecor (1946) that, in the terminology of biological and mathematical statistics, Galton's descriptive term "regression" has largely replaced the technical word "function" used by the mathematicians. For example, growth curves are referred to as the regression of height on age, or possibly weight on age. In this particular study the simple regression coefficients have been calculated for the various growth phenomena. These are presented in Table VIII and IX for all ages where measurements were taken. The fourth week regression coefficient (Table IX) for weight x shank, males, is 0.006. For each one-gram change in the weight there would be a change of 0.006 centimeter in shank length. The male, shank x depth regression for the fourth week was 0.561 in Table IX. Here, for each centimeter variation in shank length there is slightly more than one-half centimeter variation in body depth. The very small values secured when weight is considered is due to the fact that the weight unit was the gram while the linear unit used was the centimeter. Actually, these regression values set out the amount of change taking place in one variable for each unit of change in the contrasted variable. As can be noted, these values tend to be altered by changes in age excepting when the rate of growth is fairly constant. For example, the rate of over-all growth and metabolic function is well established apparently by the fourth week, as seen in Table VIII, weight x shank, for both sexes, .005 males and .007 for females. These regression coefficients compare with the first week figures of 0.15 for males and 0.17 for females. It may be noted that the magnitude of regression has diminished. After the fourth week the regression values are relatively constant. The eighth week figures, for instance, are .004 for males and .004 for the females. Up until the fourth week, however, the weight varied considerably for each unit change in shank length. We would assume this to be a characteristic of early growth procedure. The literature did not disclose data for avian species with which these figures could be compared.

Table VIII. Regression Coefficients, 175 Males-179 Females

	1st Week		2nd Week		3rd Week		4th Week		5th Week		6th Week	
	M	F	M	F	M	F	M	F	M	F	M	F
Weight x Shank*	.015	.017	.010	.014	.009	.005	.007	.006	.006	.006	.007	.006
Weight x Depth	.014	.014	.012	.013	.008	.010	.006	.008	.006	.007	.004	.005
Weight x Keel							.006	.006				
Weight x Breast							.001	.001				
Shank x Depth	.735	.724	.866	.782	.856	.844	.730	.735	.794	.802	.867	.777
Shank x Keel							.661	.508				
Shank x Breast							.176	.044				
Depth x Keel							.570	.500				
Depth x Breast							.098	.035				
Keel x Breast							.139	.063				

	7th Week		8th Week		9th Week		10th Week		11th Week		12th Week	
	M	F	M	F	M	F	M	F	M	F	M	F
Weight x Shank	.004	.004	.004	.004	.004	.004	.003	.004	.003	.003	.002	.003
Weight x Depth	.004	.004	.003	.004	.004	.003	.003	.003	.002	.003	.003	.003
Weight x Keel			.003	.003							.002	.003
Weight x Breast			.0005	.0003							.0005	.0004
Shank x Depth	.767	.798	.944	.777	.703	.793	.885	.837	.852	.756	.872	.590
Shank x Keel			.756	.537							.626	.549
Shank x Breast			.031	−.018							.008	−.022
Depth x Keel			.683	.590							.629	.671
Depth x Breast			−.031	−.059							−.007	−.056
Keel x Breast			−.028	−.074							−.044	− 085

*Weight x Shank, first day: males, .008; females, .006.

Table IX. Regression Coefficients, 101 Males-96 Females

	1st Day		4th Week		8th Week		12th Week	
	M	F	M	F	M	F	M	F
Weight x Shank	.008	.010	.006	.006	.004	.004	.002	.003
Weight x Depth			.006	.006	.003	.004	.002	.002
Weight x Keel			.006	.005	.003	.003	.002	.004
Weight x Breast			.002	.001	.001	.0001	.001	.0004
Shank x Depth			.561	.353	.782	.798	.903	.778
Shank x Keel			.674	.288	.668	.645	.723	.645
Shank x Breast			.170	.020	.105	−.076	.046	.054
Depth x Keel			.654	.439	.686	.676	.690	.695
Depth x Breast			.111	.017	.029	−.095	.047	−.064
Keel x Breast			.156	.085	.023	−.047	−.052	−.057

	16th Week		20th Week		24th Week		28th Week	
	M	F	M	F	M	F	M	F
Weight x Shank	.002	.002	.002	.001	.002	.001	.002	.001
Weight x Depth	.002	.003	.002	.001	.001	.002	.002	.002
Weight x Keel	.002	.002	.002	.002	.001	.002	.002	.001
Weight x Breast	.0004	.0004	.0005	.0002	.0003	.0003	.0003	.0004
Shank x Depth	.695	.721	.676	.831	.614	.795	.721	.890
Shank x Keel	.596	.497	.496	.572	.475	.657	.566	.676
Shank x Breast	−.038	−.058	−.064	−.069	−.442	−.028	−.059	−.057
Depth x Keel	.674	.613	.509	.566	.516	.496	.474	.644
Depth x Breast	.040	−.043	−.256	−.088	−.088	−.038	−.053	−.037
Keel x Breast	.015	−.056	.004	−.092	−.056	−.053	−.032	.021

The existence of sex differences for the various growth points, however, which was thought to be of special interest, was the age at which these sex differences become significantly apparent. From the measurements taken, *t* tests have been calculated for existent sex differences for the several growth criteria studied, excepting breast score. The criteria presented in Table X are body weight, shank length, body depth and keel length. It may be noted that significant weight differences occur by the first week and are highly significant by the end of the third week. An especially interesting phenomenon is the occurrence of a highly significant sex difference for length of shank (tarsometatarsus) on the day of hatching. Sex differences for anterior body depth are significant by the third week and highly significant by the fourth week. The difference in length of sternum or keel was highly significant by the eighth week.

Table X. Calculated *t* Tests of Sex Difference For Several Criteria of Growth

	1st Day	1st Week	2nd Week	3rd Week	4th Week	8th Week
Weight	1.580	2.062*	2.147*	3.118**	4.981**	11.685**
Shank	3.339**	3.782**	3.869**	4.464**	5.032**	12.327**
Body Depth		0.570	1.365	2.214*	2.768**	9.082**
Keel Length					1.119	7.453**

* t.05
** t.01

Studies by Jull (1923) and Jull and Quinn (1925) suggest a slight sex difference for weight in favor of the male at day old; however, the differences found were not shown to be statistically significant. Their logical conclusion was that weight of day-old chicks was not a reliable indication of sex. Munro and Kosin (1940) state that they found a sex difference in the day-old weight of male and female sibs. Their difference in favor of males ranged from 0.6 to 1.8 per cent when body weight was expressed as a percentage of egg weight.

With relatively small samples used in this experiment it was not possible to detect a significant sex difference in weight for the day-old chicks. As pointed out this difference was significant by the end of the first week and continued so thereafter.

Table XI presents the basic breast score data. The method used in securing data and calculating mean breast score is described in the experimental procedure section.

It may be noted from Tables III and IV that the breast score is more highly associated with body weight than with any of the other criteria. In most cases with this relationship the coefficients are hardly significant. From this we can assume that breast score as secured for this study is not strongly enough associated with the other criteria measured to be of practical value.

Table XI. Table of Breast Score Data

Age	Sex	Mean Keel Length	Wire Length	Mean Breast Score
4 Weeks	Male	5.11	2.55	1.68
	Female	4.95	2.47	1.61
8 Weeks	Male	7.70	3.85	2.36
	Female	7.16	3.58	2.26
12 Weeks	Male	9.59	4.79	2.93
	Female	9.07	4.53	2.80
16 Weeks	Male	10.70	5.35	3.28
	Female	9.98	4.99	3.16
20 Weeks	Male	11.72	5.86	3.60
	Female	10.67	5.34	3.64
24 Weeks	Male	12.44	6.22	3.95
	Female	11.25	5.62	3.91
28 Weeks	Male	12.75	6.37	4.19
	Female	11.18	5.59	3.92

Also, the inter-age correlation coefficients (Table V) do not indicate favorable predictive values. As might be expected we note that breast score at a given age is the best criteria to use in predicting future breast score. Even here, however, the values are not large. For example the twelfth week x twenty-eighth week correlation for breast x breast is only 0.579. This is the highest inter-age correlation involving breast score.

SUMMARY AND CONCLUSIONS

A study of the growth procedure in the Dark Cornish fowl, *Gallus domesticus,* has been made. The time interval covered was from the day of hatching through the twenty-eighth week. It was thought that this period would include the full process of maturation for this variety of domestic chicken. Three hundred and eighty-four chicks were initiated into the trial. This included 205 day-old male chicks with mean weight of 31.7 grams and 179 female chicks averaging 31.0 grams. This entire group, less mortality, was carried through the first twelve weeks growth period. Weekly measurements were secured during this time. One hundred seventy-five males and 179 females completed this phase. At the end of twelve weeks random samples of approximately 100 males and 100 females were selected to be measured at four-week intervals through the twenty-eighth week. One hundred and one males and 96 females completed this latter growth period.

The growth criteria measured throughout this study were body weight, shank (tarsometatarsus) length, keel (sternum) length, anterior body depth and breast width score.

Throughout the trial all controllable environmental conditions were maintained as nearly uniform as possible. Every reasonable effort was taken to provide the birds with the optimum conditions for normal growth. Disease outbreaks were successfully avoided throughout the trial.

The actual measurements of the growth criteria for the individual birds have been extensively studied. Means for weight, shank length, keel length, body depth and breast width score have been obtained. These means are graphically presented in the several figures. The means, standard deviations and the coefficients of variability are presented in tabular form.

The inter-relationship of the five growth processes was studied by means of the correlation and regression procedures as set out by Snedecor (1946). Simple correlation coefficients have been secured and are presented in Tables III and IV. This information is presented for all growth criteria measured for each time interval. Inter-age correlation coefficients involving the birds at the fourth, twelfth and twenty-eighth week appear in Table V. In addition both inter-age and intra-age correlation coefficients have been calculated for the particular ages and criteria thought to be the most significant. This information appears in Tables VI and VII.

Regression coefficients were calculated for each possible comparison of the growth criteria studied. These included each age interval used throughout the trial. This information appears in Tables VIII and IX.

Throughout the analysis of the data differences due to sex were apparent. The age at which these sex differences were initiated was calculated by the *t* test method. This information is set out in Table X.

Startling conclusions were not anticipated as a part of the results of this basic growth study. Considerable information concerning the growth processes for the Dark Cornish fowl is included here which has not been presented heretofore. Also, basic data pertaining to sex differences have been secured. Certain of these observed sex differences as set out in this work may have been undetected before. For example, no previous reference to a significant sex difference for the length of the tarsometatarsus in day-old chicks was found. While this particular phenomenon may not be generally apparent in all breeds of *Gallus domesticus* it has been proved statistically valid in this work. Other phases of this study may be in a like position so far as potential scientific application is concerned. It may be said in final support of any growth study that its merit rests upon its reference value and not upon any immediate application of the basic information secured.

A few of the basic conclusions which may be drawn from the analysis of these growth data are set out below.

(1) The variance within both sexes for the weight measurement was shown by the coefficient of variability to be greatest at the third week of age. This is also true for the linear development of the tarsometatarsus, for both sexes. These two criteria, weight and shank length, are probably the best measures used for mass and skeletal development. Variability may be at its peak during the third week due to physico-chemical adjustments going on at this time just prior to the onset of the most rapid

stage of development. This would seem to be the best time to select for genetic variability in these traits.

(2) After one week's growth, increments in weight are significantly associated with growth of the long bones and with anterior body depth. Measurements taken at the fourth week showed that weight is highly correlated with length of sternum and is correlated to a lesser extent with breast width score. These trends apply to both sexes.

(3) Shank length and anterior body depth are significantly correlated at one week of age. At four weeks of age shank length and length of sternum (keel) are correlated. Shank length and breast width score are significantly related at this time for the males; however, the female correlation coefficient, while positive, is not significant for this relationship.

(4) The correlation of body depth and keel length is significant at the fourth week for both sexes. The body depth, breast width relationship is barely significant for males and non-significant for the females.

(5) Length of sternum (keel) is significantly correlated with breast width score for males at the fourth week. The coefficient is not significant for the female at this age.

(6) This study indicates that, in general, the criteria of weight, shank length, anterior body depth and keel length are all correlated one with another to a highly significant degree (that is, to the 1 per cent level of probability). The values calculated have usually accounted for from 50 to 60 per cent of the variance. This was found to be true for both sexes.

(7) Body weight was found to bear a low but significant correlation with breast width score for both sexes. In general the coefficients for shank length and breast score, body depth and breast score or keel length and breast score were not significant for either sex. These trends are probably due to the fact that the breast width score as taken was more a measure of fullness or roundness of the breast rather than a measure of the mass development of the pectoralis major.

(8) The inter-age correlation coefficients indicate that weight at a given age is the best criterion for predicting weight at a future age. For example weight at twelve weeks has a correlation value with weight at twenty-eight weeks of 0.971 for males. It seems that selection pressure for weight might very well be emphasized at the twelfth week on the basis of this high correlation. Of all criteria used, the next highest value for twelfth week x twenty-eighth week males is weight x keel, that being 0.451. This same tendency, while not unexpected, seems to apply for all other criteria used in this study. Also, as might be expected, as the length of the inter-age period is increased the predictive values diminish. For example, shank x shank for the period fourth week x twelfth week for females has a value of 0.507. This value is reduced to 0.310 when extended over the period of fourth week x twenty-eighth week.

(9) In most instances the intra-age multiple correlation coefficients did not appreciably increase the predictive values over the simple correlations. The slight increase noted in some of the values can be seen in the following example. The simple correlation of weight and shank for twenty-eight week males was 0.839. When keel and shank are used together to predict weight the multiple coefficient is 0.93.

(10) The inter-age multiple correlation coefficients do not give any appreciable increase in predictive value over the simple intra-age coefficients.

(11) The regression coefficients as calculated gave valid estimates of the degree of change in one of the growth criteria studied when the comparable criterion is held constant. It appears that in most comparisons the regression values are fairly well stabilized after the fourth week. Instability during the first four weeks may be due to physico-chemical growth adjustments in the individual birds.

(12) Significant sex differences were found in the length of the tarsometatarsus in newly hatched chicks of this strain of Dark Cornish fowl. Valid sex differences were detected for weight in the week-old chicks. A true difference between the sexes was found for body depth at three weeks of age. The sex differential for length of sternum was not significant at four weeks of age. When this criterion was measured again at the eighth week the difference was highly significant.

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Nutritional Status of Preadolescent Boys and Girls in Selected Areas of Louisiana

By

Dorothy Moschette, Kathryn Causey, Echo Cheely,
Margaret Dallyn, Laureame McBryde and Ruth Patrick

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NUTRITIONAL STATUS OF PREADOLESCENT BOYS AND GIRLS IN SELECTED AREAS OF LOUISIANA

Dorothy Moschette, Kathryn Causey, Echo Cheely,
Margaret Dallyn, Laureame McBryde and Ruth Patrick

INTRODUCTION

The nutriture of Louisiana boys and girls is a subject of concern for all Louisianians and one of the primary concerns of our agricultural industry. Dr. C. G. King, Scientific Director of the Nutrition Foundation, has stated, ". . . there should be no doubt of the value of nutrition surveys as a means of evaluating where we stand with respect to accomplishing the goal of a well-nourished population."

In addition, results from nutrition surveys provide valuable information which should be used in the direction of food production and distribution programs. Within the past few years several outstanding nutritional status studies, designed to furnish data on the nutriture of varied population groups throughout the United States, have been in progress.

Included among these are the Northeastern, North Central, Western, and Southern Regional Research Projects, financed in part by funds appropriated under the Research and Marketing Act of 1946. Many of the measurements made are similar, although the population groups differed in age and location within each region as well as between regions. The use of similar techniques makes possible a comparison of nationwide results and the compilation of data from which many facts related to nutrition can be acquired. The reports of results from such studies in Oregon and in New York State are already available.

For the purpose of raising our levels of nutrition among school children it is important that surveys of many types be conducted at frequent intervals to determine their present status. For the past five years staff members of the Louisiana Agricultural Experiment Station have been engaged in nutrition surveys of school children. This report, on the Nutritional Status of Preadolescent Boys and Girls in Selected Areas of Louisiana, is based upon data collected as a part of sub-project 2 of the Southern Regional Research Project on *Assessments of Nutritional Status of Humans.*

PURPOSE AND PLAN OF THE STUDY

This study of the nutritional status of preadolescent elementary school children was begun in February, 1950, and completed in December, 1951. The purposes of the investigation were: (1) to determine the nutritional status including the detection of mild and moderate deficiency states, (2) to determine food intake of the experimental groups and to investigate possible relations between intake of specific nutrients and the serum levels of certain blood constituents, and (3) to study the association between the prevalence of clinical manifestations of a nutritional deficiency and the corresponding nutrient intake and blood level.

The measurements and records used for obtaining the necessary information included a seven-day dietary study, height and weight measurements, biochemical tests on blood samples and clinical examinations for signs of nutritional deficiencies. To carry out this work, a regular routine was established. After the necessary contacts were made with school authorities and written permission was obtained from the parents, the schools were visited by the nutritionist and the dietary records of the children begun.

For the biochemical tests, two blood samples were taken from each child. These non-fasting samples were drawn a week apart on a Wednesday forenoon. Samples were drawn from 25 to 30 subjects each week. Two biochemists drew and analyzed all the samples, thereby eliminating differences due to varied techniques. The physical and clinical examinations were given to each school group on the same day. A team of three physicians headed by Dr. Grace Goldsmith of Tulane University examined the children for signs and symptoms of nutritional deficiency. Each physician had a recorder to check the results of his examination on a standard form devised by the physician in charge. The children were weighed and measured by two members of the Louisiana State University home economics staff assisted by the resident public health nurses. The results were recorded upon a data card given to each child. These cards were collected and the other data for each child added later in the laboratory. A total of 552 children was examined; however, completed records for all four types of measurements were obtained on 487 subjects.

DESCRIPTION OF SAMPLE

In choosing subjects for the project, it was decided to limit the age of the children studied to eight through eleven years, to include an equal distribution of white boys and girls, and to study at least 100 subjects from any chosen community. The ages eight through eleven were defined to include a child from seven years six months to eleven years five months; for example, an eight year old was any child from seven years six months to eight years five months. The children's birth dates were given by their parents on the letters granting permission to include the children in the experimental group. These birth dates were verified from birth records on file with the school principals. The ages recorded for the subjects were their ages on the day the study began in their school. The distribution of the subjects according to age and the dates for beginning work with each group are given in Table 1.

The sampling for a previous study (23) on Louisiana preadolescents had been based on the proportion of the white elementary school population in each of the four large agricultural areas of the state to that of the total in the entire state. For the present study, therefore, it was considered worth-while to select, in so far as it was possible, children from communities in each of the four agricultural areas that had not been included before. Children from five parishes, Iberville, St. Tammany, East Baton Rouge, Orleans, and Bossier, were selected.

The schools, in the five parishes selected, varied in type and character. The first 100 children studied were in Iberville Parish and attending Crescent and Plaquemine elementary schools. This parish is in a sugar cane area. The principal occupations are farming, fishing, and employment in nearby industrial plants. Crescent school is rural, five miles from the town of Plaquemine on Bayou Plaquemine. There were not 100 students within the age limit in Crescent school, so additional subjects were selected from one of the nearby Plaquemine schools to complete the quota from this community.

The second 100 subjects chosen were from students attending Covington Grammar school of St. Tammany Parish. St. Tammany is situated in the extreme eastern part of the state and is principally a dairy and truck-farming area. Covington is the parish seat; however, many of the students come to school by bus from nearby farms. At the request of the principal all of the children 8 to 11 in this school were included in the examinations.

The third 100 cases were from Highland and Woodlawn schools of East Baton Rouge Parish. This parish is the site of the state capitol, the state university, and several very large chemical plants and oil refineries. Highland is an elementary urban school located in a suburb of Baton Rouge near the university. There were only 66 children from 8 to 11 years of age available at Highland. Woodlawn is 10 miles from Baton Rouge in a rural area and both the elementary and high schools are housed in the same plant.

The fourth group of children resided in Orleans Parish. The whole of this parish is within the city limits of New Orleans. Gentilly Terrace, the school selected for study, is located in a desirable residential area of New Orleans and is urban in all respects. Most of the parents of the children were professional men and women or employed in saleswork, or as craftsmen or owner operators.

The children in the last group studied were residents of Bossier Parish and were attending one of Bossier City's elementary schools. Bossier Parish, in northwestern Louisiana, is in the Red River Delta cotton area. A large percentage of its inhabitants are engaged in farming. Although some of the children in Bossier City Elementary school came by bus from outlying farms, a majority were from the town and air base located there. The number of cases included from this parish fell below 100 because many of the children lacked a clinical examination. A distance of over 300 miles from the examining physician's office created unsurmountable problems. The exact number of children from each parish and school for whom all records were completed is given in Table 1. The percentage of the total enrollment for each school included in the sample is also given in Table 1.

TABLE 1. Distribution of 487 Subjects According to Location, Age, and Time of Study

Location		Number of Subjects						Per Cent of Total School Enrollment	Beginning Date of Study
Parish	School	Parish Total	Age in Years				School Total		
			8	9	10	11			
Iberville		97							1950
	Crescent		17	11	24	18	70	37	February
	Plaquemine		10	8	4	5	27	5	March
St. Tammany		100							
	Covington		21	29	26	24	100	18	April
East Baton Rouge		117							
	Highland		18	16	14	18	66	18	September
	Woodlawn		12	15	15	9	51	17	October
Orleans		111							
	Gentilly Terrace		19	32	26	34	111	11	November
Bossier		62							1951
	Bossier		13	12	23	14	62	6	March
	Total	487	110	123	132	122	487		

EXPERIMENTAL

Dietaries

Dietary studies alone are not a direct assessment of nutriture, but they do yield valuable information regarding dietary patterns of groups of people and give certain presumptive evidences of malnutrition. Knowledge of food habits offers a basis for correction of malnutrition as detected by biochemical tests and clinical examinations. One of the limiting factors when evaluating dietary data is the standards used for comparison. The widely used Recommended Dietary Allowances of the National Research Council (15) are merely guides to optimal nutrition and are not intended to represent absolute requirements.

For collecting dietary information on these 487 preadolescents, each child was given printed forms upon which to record all food and drink consumed during a seven-day period, beginning and ending on a Wednesday. The kind and quantity of food consumed was recorded in household measures, and listed under the headings of breakfast, lunch, supper, and between-meals. The mothers of the eight year old group were visited by the nutritionist and given instructions for keeping the records and determining quantities of all the food eaten at home. The nutritionist recorded their school lunch. The nine, ten and eleven year olds kept their own records after having been given specific instructions. They met in individual groups each morning with the nutritionist and completed their records for the evening meal of the day before, their breakfast, and all food eaten between meals. Following the school lunch, another conference was held at which the children recorded amounts eaten. The school lunch menu had been listed for them to check. Saturday's and Sunday's records were kept on different colored sheets given out on Friday afternoons. A conference was held with the children in small groups on Monday morning for checking these forms before the figures from them were transferred to their permanent 7-day record. The same nutritionist collected the diet records for all subjects. She lived in each community during the period in which the dietary data were collected. The excellent cooperation from school officials, classroom teachers, and lunch-room personnel made possible the taking of accurate records from so many school children.

The diet record of each child was tabulated. Since foods eaten by the children were similar, it was found that for the most part 142 individual food items covered the selection. For ease in tabulation and for use in the calculations by International Business Machines, the 142 food items were given code numbers. Foods that were seldom consumed and which had no assigned code numbers were classified under the food with a code number which had the most similar nutritive composition. Artichokes, for example, were coded under cabbage, and cheetos under cheese crackers.

The individual nutrients for each food item were calculated on the basis of common household units. These values, whenever possible, were taken from *Composition of Foods,* United States Department of Agriculture (37). *Food Value of Portions Commonly Used,* Bowes and Church (7), was used as a supplement. The nutritive value of foods peculiar to this area, such as gumbo and jambalaya, was calculated on the basis of a typical recipe.

Food items were tabulated with individual codes for International Business Machine calculations to obtain totals for each child's 7-day nutrient intake. From these the individual mean daily intake was obtained.

The mean daily intake of calories and nine nutrients as calculated from the 7-day food records of 487 children is reported in Table 2. Individual weaknesses are lost in averages; therefore, to show more clearly the calorie and nutrient intakes, individual dietary intakes for the various age groups and the entire group were evaluated using the Recommended Dietary Allowances of the National Research Council (15) as a standard of 100 per cent.

The calorie intake of the 487 preadolescents, according to age, was arbitrarily classified into various levels of deviation from the N. R. C. recommended dietary allowances (Figure 1). Twenty-nine per cent of all the children met calorie intakes within 10 per cent of these daily allowances. More than 60 per cent of the eight and nine year olds had calorie intakes greater than this range, and over 10 per cent of these age groups had intakes which exceeded the allowance by more than 50 per cent. Approximately 25 per cent of the 10 and 11 year olds had in-

TABLE 2. Mean Daily Nutrient Intake of 487 Preadolescent Children

Nutrient	Mean	Standard Deviation	Range
Calories	2401 cal.	593	1164 to 5194
Protein	89.0 gm.	7.2	42.7 to 221.7
Calcium	1.202 gm.	0.55	0.35 to 3.38
Phosphorus	1.529 gm.	0.33	0.74 to 4.73
Iron	11.96 mg.	3.56	6.0 to 27.7
Vitamin A value	6181 I. U.	3946	1109 to 32030
Thiamine	1.27 mg.	0.32	0.60 to 3.00
Riboflavin	2.23 mg.	0.55	0.91 to 4.98
Niacin	14.59 mg.	4.3	5.43 to 35.55
Ascorbic acid	80.0 mg.	46.3	12 to 277

takes which exceeded 10 per cent of the recommendations, and 10 per cent of this age group had less than two-thirds of the recommended daily allowance.

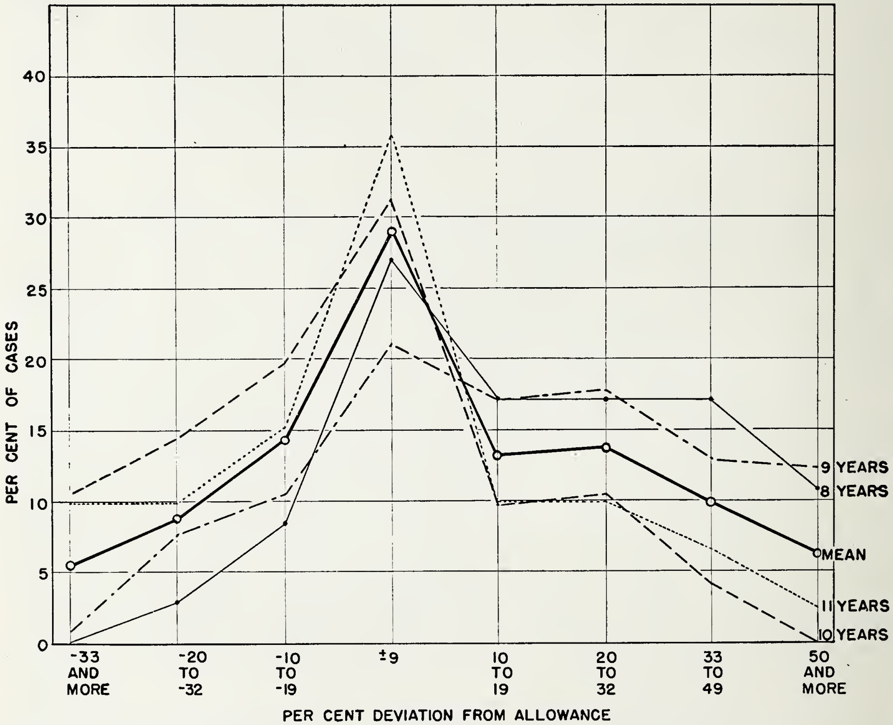

FIGURE 1: CALORIC INTAKE: PERCENTAGE DEVIATION FROM NATIONAL RESEARCH COUNCIL RECOMMENDED ALLOWANCES ACCORDING TO AGE.

For evaluation of the nutrient intakes, each diet was arbitrarily classified into one of three categories:

100 per cent or above the N. R. C. recommended dietary allowance;
66.7 per cent to 99.9 per cent of the N. R. C. allowance;
66.6 per cent or below the N. R. C. allowance.

Grouping of the results into these categories (Figure 2) revealed that the greatest proportion of eight and nine year olds had an excellent intake of all nutrients except ascorbic acid. More than 70 per cent of the children met or exceeded the National Research Council's recommended allowance for the other nutrients, but only 21 per cent met the recommended allowance for ascorbic acid. Sixteen per cent received less than two-thirds the daily allowance for ascorbic acid.

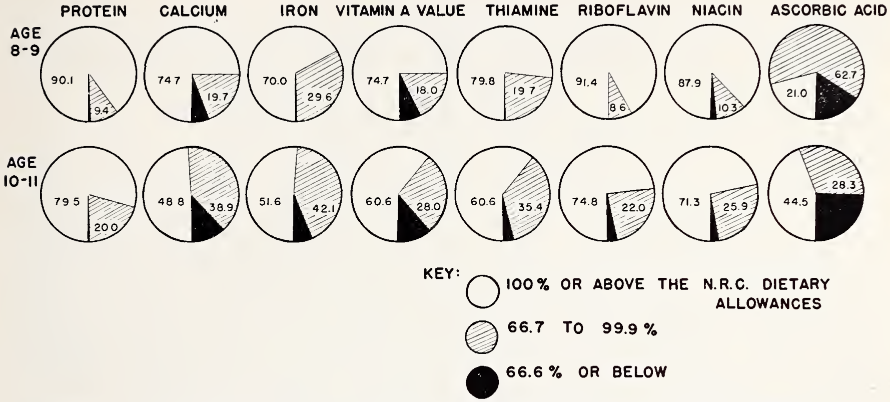

FIGURE 2: THE PERCENTAGE OF DIETS THAT MET EACH OF THREE LEVELS OF THE N.R.C. DIETARY ALLOWANCES FOR EIGHT NUTRIENTS

A much larger percentage of these eight and nine year old children met or exceeded the recommended allowances than did the ten and eleven year olds. Young, Smudski and Steele (44) in studying the dietary intakes of 69 seven to nine year old children and 48 ten to twelve year old children found that the percentage of children that fully met the recommended dietary allowances decreased as age increased. Similarly, Young and Pilcher (43) found younger children (under ten) to have the most adequate nutrient intakes. The mean nutrient intake for the ten and eleven year olds of the present study, however, appeared to be good; approximately 90 per cent ingested over two-thirds the recommended allowance of most nutrients. Following the same trend as did the eight and nine year old group, a smaller percentage of the children met the recommended allowance for ascorbic acid. Forty-five per cent of the subjects received at least 100 per cent of the allowance and 27 per cent ingested less than two-thirds. Intake of calcium was also low for this age group. Forty-nine per cent met or exceeded the daily allowance, but 12 per cent received less than two-thirds. Results of dietary studies by other workers (38, 44) indicated that ascorbic acid is the nutrient most likely to be inadequate in the diet of preadolescents, calcium ranking second poorest. Thomas *et al* (36) upon analyzing both fall and spring diets of four preadolescent children found ascorbic acid to be the nutrient which less frequently met the recommended allowance. In studying older children, 14 to 16 years of age, Storvick *et al* (32) likewise found ascorbic acid, along with iron and calcium, to be the nutrient most often inadequate in the diets. Less than two-thirds of the daily allowances were met by the diets of 25 per cent of the children for ascorbic acid, 21 per cent for iron, and 14 per cent for calcium.

TABLE 3. Classification of the Diets of 487 Children According to Three Levels of the Recommended Dietary Allowance of the National Research Council

Per Cent of Allowance	Protein	Calcium	Iron	Vitamin A Value	Thiamine	Riboflavin	Niacin	Ascorbic Acid
			Per cent of diets that met each level					
100% or above	84.6	61.2	60.4	67.4	69.8	82 8	79.3	53.2
67.7 to 99.9%	14.9	29.8	36.1	23.2	27.9	15.6	18.5	24.8
66.6% or below	0.4	9.0	3.5	9.4	2.3	1.6	2.2	22.0

In the present study, 90 per cent of the children of all ages (Table 3) received more than two-thirds of the recommended daily allowance of all nutrients except ascorbic acid. A larger percentage of children met the protein allowance than that of any other nutrient. Eighty-five per cent of the children met or exceeded the allowance, showing a superior intake of protein to that of the children reported in other studies. (32, 44).

The mean daily intake of calories and eight nutrients for the 487 children was calculated according to age and school (Tables 4-12). The schools are listed in decreasing order in regard to amount of nutrient intake, and the recommended allowance of the National Research Council is given for comparison.

In viewing the mean calorie intake (Table 4) of the entire group from each school, Plaquemine and Covington fall slightly below the average National Research Council's allowance. The low calorie intake of the ten and eleven year olds in both schools decreased the average for the four ages.

The intake of protein (Table 5) was excellent. All age groups in every school had a mean daily protein intake which exceeded the National Research Council's recommendation of 70 grams for the oldest age group included in the study. Mean daily calcium intakes (Table 6) for all age groups ranged from 1.35 grams at Crescent to 1.06 grams at Bossier. The children at Bossier and Plaquemine had mean daily calcium intakes which were slightly less than that of the National Research Council's allowance, but the children at the other schools had intakes which exceeded the recommendations. Iron intake (Table 7) was very good for the children in most schools. Plaquemine and Covington children on the average had intakes slightly below the recommended allowance owing to the poorer intake of the ten and eleven year olds.

The vitamin A intake (Table 8) of the total group was excellent in all schools; however, the vitamin A intake of the Plaquemine ten and eleven year olds was considerably less than the allowance. Thiamine intakes (Table 9) were good in the majority of the schools, but again the poorer intakes of the Plaquemine and Covington ten and eleven year olds made the group's mean intake slightly less than the National Research Council's allowance. Riboflavin and niacin intakes (Tables 10 and 11) were excellent in all schools. Ascorbic acid intake (Table 12) was very good for the Crescent children but low for Covington and Plaquemine.

TABLE. 4. Mean Daily Calorie Intake of 487 Prealodescents According to Age and School

School	Total No. of Subjects	All Ages	Age				Recommended N. R. C. Allowance	
			8 yrs.	9 yrs.	10 yrs.	11 yrs.	7-9 yrs.	10-12 yrs.
			Calories					
Gentilly Terrace	111	2674	2796	2599	2686	2668	2000	2500
Crescent	70	2595	2495	2511	2585	2755		
Woodlawn	51	2533	2676	2728	2347	2553		
Highland	66	2361	2369	2334	2251	2464		
Bossier	62	2317	2264	2255	2345	2375		
Plaquemine	27	2160	2109	2151	2256	2204		
Covington	100	2111	2285	2013	2043	2150		

TABLE 5. Mean Daily Protein Intake of 487 Preadolescents According to Age and School

School	Total No. of Subjects	All Ages	Age				Recommended N. R. C. Allowance	
			8 yrs.	9 yrs.	10 yrs.	11 yrs.	7-9 yrs.	10-12 yrs.
			Grams					
Gentilly Terrace	111	99.0	99.4	98.4	103.3	96.2	60	70
Crescent	70	95.3	89.6	89.1	96.0	103.9		
Woodlawn	51	94.0	91.8	101.3	92.2	87.8		
Highland	66	87.7	85.6	86.8	83.9	93.8		
Bossier	62	83.6	79.8	85.7	85.6	82.2		
Covington	100	78.9	85.4	74.4	76.2	81.5		
Plaquemine	27	75.3	76.3	78.9	70.4	71.4		

TABLE 6. Mean Daily Calcium Intake of 487 Preadolescents According to Age and School

School	Total No. of Subjects	All Ages	Age				Recommended N. R. C. Allowance	
			8 yrs.	9 yrs.	10 yrs.	11 yrs.	7-9 yrs.	10-12 yrs.
			Grams					
Crescent	70	1.352	1.256	1.225	1.316	1.581	1.0	1 2
Gentilly Terrace	111	1.270	1.425	1.286	1.269	1.170		
Highland	66	1.259	1.340	1.332	1.098	1.154		
Covington	100	1.167	1.138	1.122	1.111	1.132		
Woodlawn	51	1.139	1.121	1.224	1.107	1.077		
Bossier	62	1.094	1.014	1.110	1.168	1.036		
Plaquemine	27	1.060	1.022	1.206	0.912	1.022		

TABLE 7. Mean Daily Iron Intake of 487 Preadolescents According to Age and School

School	Total No. of Subjects	All Ages	Age				Recommended N. R. C. Allowance	
			8 yrs.	9 yrs.	10 yrs.	11 yrs.	7-9 yrs.	10-12 yrs.
				Mg.				
Crescent	70	13.5	12.5	12.5	12.9	15.8	10	12
Gentilly Terrace	111	13.1	13.1	13.0	13.1	13.3		
Woodlawn	51	12.5	12.5	13.6	11.7	12.0		
Bossier	62	11.8	11.6	12.0	12.0	11.7		
Highland	66	11.3	10.8	10.7	11.0	12.6		
Plaquemine	27	10.6	11.1	10.8	10.0	10.2		
Covington	100	10.2	10.5	9.6	9.8	10.8		

TABLE 8. Mean Daily Vitamin A Intake of 487 Preadolescents According to Age and School

School	Total No. of Subjects	All Ages	Age				Recommended N. R. C. Allowance	
			8 yrs.	9 yrs.	10 yrs.	11 yrs.	7-9 yrs.	10-12 yrs.
				I. U.				
Woodlawn	51	7136	6334	7099	8051	6740	3500	4500
Gentilly Terrace	111	6984	8338	7396	6310	6354		
Bossier	62	6216	6434	5557	6570	5992		
Highland	66	6198	6883	5348	5953	6460		
Crescent	70	6064	6352	5515	6539	5495		
Covington	100	5359	6083	5044	4803	5710		
Plaquemine	27	4338	4391	5513	3203	3260		

TABLE 9. Mean Daily Thiamine Intake of 487 Preadolescents According to Age and School

School	Total No. of Subjects	All Ages	Age				Recommended N. R. C. Allowance	
			8 yrs.	9 yrs.	10 yrs.	11 yrs.	7-9 yrs.	10-12 yrs.
				Mg.				
Woodlawn	51	1.42	1.35	1.58	1.30	1.42	1.0	1.2
Gentilly Terrace	111	1.38	1.40	1.38	1.38	1.37		
Crescent	70	1.34	1.25	1.34	1.31	1.46		
Bossier	62	1.26	1.16	1.32	1.28	1.25		
Highland	66	1.21	1.22	1.19	1.15	1.26		
Plaquemine	27	1.16	1.19	1.21	1.15	1.03		
Covington	100	1.09	1.09	1.06	1.08	1.13		

TABLE 10. Mean Daily Riboflavin Intake of 487 Preadolescents According to Age and School

School	Total No. of Subjects	All Ages	Age				Recommended N. R. C. Allowance	
			8 yrs.	9 yrs.	10 yrs.	11 yrs.	7-9 yrs.	10-12 yrs.
				Mg.				
Gentilly Terrace	111	2.42	2.69	2.47	2.40	2.23	1.5	1.8
Crescent	70	2.36	2.26	2.11	2.36	2.63		
Highland	66	2.23	2.27	2.25	2.14	2.24		
Woodlawn	51	2.20	2.10	2.37	2.21	2.08		
Covington	100	2.12	2.28	2.03	1.93	2.29		
Bossier	62	2.01	1.94	1.94	2.14	1.95		
Plaquemine	27	1.91	1.91	2.12	1.66	1.80		

TABLE 11. Mean Daily Niacin Intake of 487 Preadolescents According to Age and School

School	Total No. of Subjects	All Ages	Age				Recommended N. R. C. Allowance	
			8 yrs.	9 yrs.	10 yrs.	11 yrs.	7-9 yrs.	10-12 yrs.
				Mg.				
Woodlawn	51	17.09	16.36	18.10	17.01	15.72	10	12
Gentilly Terrace	111	16.60	16.03	16.34	17.77	16.28		
Highland	66	14.77	14.10	13.56	13.45	17.54		
Crescent	70	14.48	13.50	15.03	14.15	15.49		
Bossier	62	13.86	13.32	14.79	13.97	13.38		
Plaquemine	27	12.49	13.28	12.87	9.97	12.29		
Covington	100	11.99	12.66	11.18	11.78	12.63		

In viewing the average intake of each nutrient for all the children in the various schools, the recommended allowances of the National Research Council were met in most instances. It is interesting to note, however, that the mean nutrient intake was considerably better in some schools than in others. The subjects from Gentilly Terrace and Crescent were nearly always the two groups with the highest intake of each nutrient and the children of Plaquemine and Covington had the lowest intake. Most important is that with the exception of ascorbic acid and calorie intakes of the boys and girls in Plaquemine and Covington, the children from every school probably had a mean nutrient intake which was adequate. If the nutrients were singled out in each school for the ten and eleven year olds, however, intake was not always adequate.

TABLE 12. Mean Daily Ascorbic Acid Intake of 487 Preadolescents According to Age and School

School	Total No. of Subjects	All Ages	Age				Recommended N. R. C. Allowance	
			8 yrs.	9 yrs.	10 yrs.	11 yrs.	7-9 yrs.	10-12 yrs.
				Mg.				
Crescent	70	106	91	118	98	123	60	75
Gentilly Terrace	111	88	108	84	78	87		
Woodlawn	51	88	94	96	72	93		
Bossier	62	74	79	86	68	70		
Highland	66	71	85	67	64	66		
Covington	100	66	69	68	60	68		
Plaquemine	27	55	60	44	39	74		

In the dietary study of these 487 preadolescents, less than ten per cent of the children failed to meet two-thirds of the recommended daily allowances for the various nutrients, with the exception of ascorbic acid. Similar results were obtained by Young *et al* (44) and Storvick *et al* (32). These average findings for the entire group indicate a fairly good mean nutrient intake; however, it is no criterion for judging the individual child. Besides nutrient intake, height-weight-age status, biochemical values, and clinical findings are needed for assessing nutriture.

Height-Weight Status

Height and body weight were obtained for each of the children. The same type of springless platform scales were used throughout the examinations. Two heavy marble bars were used for checking the uniformity of the scales at the various schools. Weights were taken without shoes and clothing except for a weighing garment, and recorded in pounds and ounces. The children were instructed to empty their bladder before weighing, and weights were not taken sooner than one-half hour after meals.

All weights were compared with the Baldwin-Wood Tables (3) to determine their deviation from the average weight for height and age (Figure 3). Of the total number of children including all age groups, only 31 per cent came within the normal, ± 4 per cent, level of deviation from the standard. Forty-eight per cent were more than 5 per cent underweight, but of this percentage, less than 2 per cent were 20 per cent or more from the standard. Twenty-two per cent were more than 5 per cent overweight. Of this percentage, 4 per cent were 30 per cent or more overweight. The eight and nine year olds had a larger percentage of cases in the normal weight range than did the ten and eleven year olds. No outstanding differences in percentage of overweight and underweight cases occurred between eight, nine, ten, and eleven year olds.

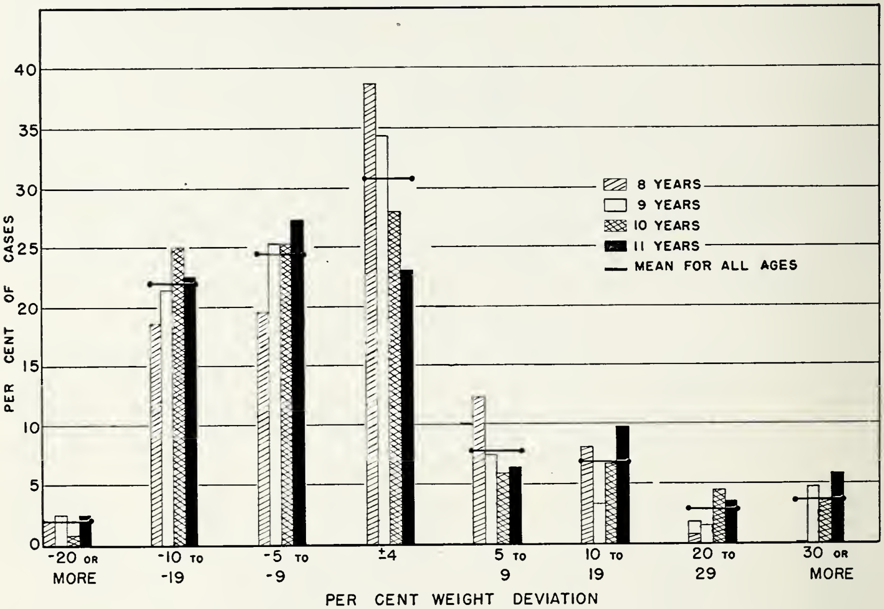

FIGURE 3: PERCENTAGE WEIGHT DEVIATION FROM NORMAL ACCORDING TO AGE.

Weight deviations of the boys and girls were calculated separately

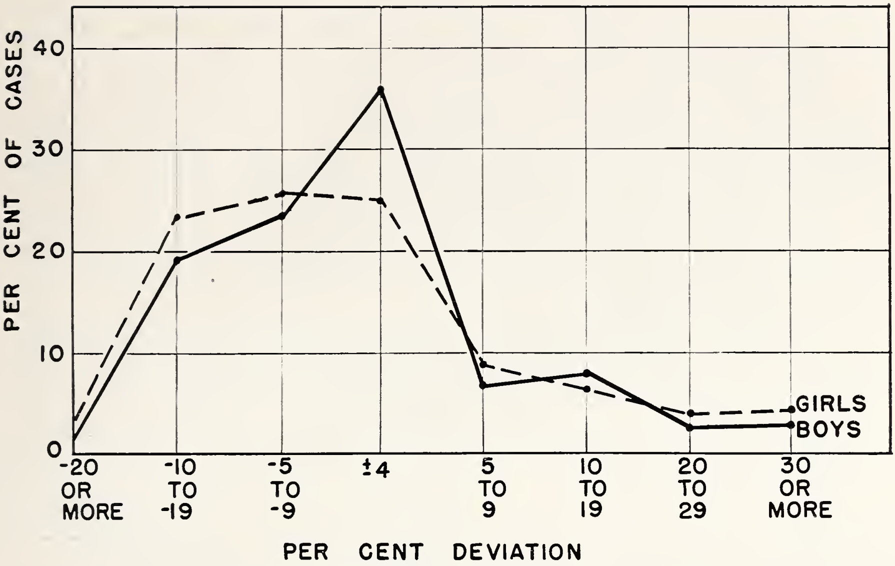

FIGURE 4: PERCENTAGE WEIGHT DEVIATION ACCORDING TO SEX.

(Figure 4). Both boys and girls tended to weigh less than the standard; however, a greater number of boys than girls were in the normal range, 36 and 25 per cent, respectively. A greater percentage of girls than boys

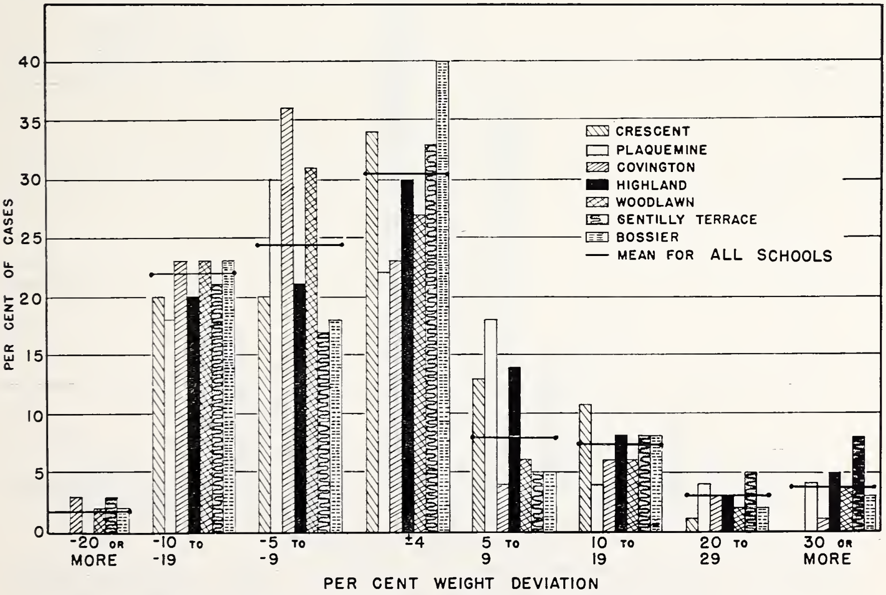

FIGURE 5: PERCENTAGE WEIGHT DEVIATION FROM NORMAL ACCORDING TO SCHOOLS.

were underweight as well as overweight. Of the four age groups, fewer cases of either sex of eight year olds appeared in the extreme overweight or underweight levels than did the nine, ten, or eleven year olds.

Percentage weight deviations were calculated for all subjects according to schools (Figure 5). In every school, more of the children were underweight than normal or overweight. Covington and Woodlawn, however, had the greatest percentage of underweight children, with 62 and 56 per cent, respectively. Plaquemine with 22 per cent and Covington with 23 per cent had the fewest children in the normal range. Gentilly Terrace had the greatest percentage of children who were more than 20 per cent overweight.

Individual calorie intake and weight deviation of each subject were correlated A positive correlation coefficient of 0.17 was found. Although so small as to be of little or no practical importance, this cor-

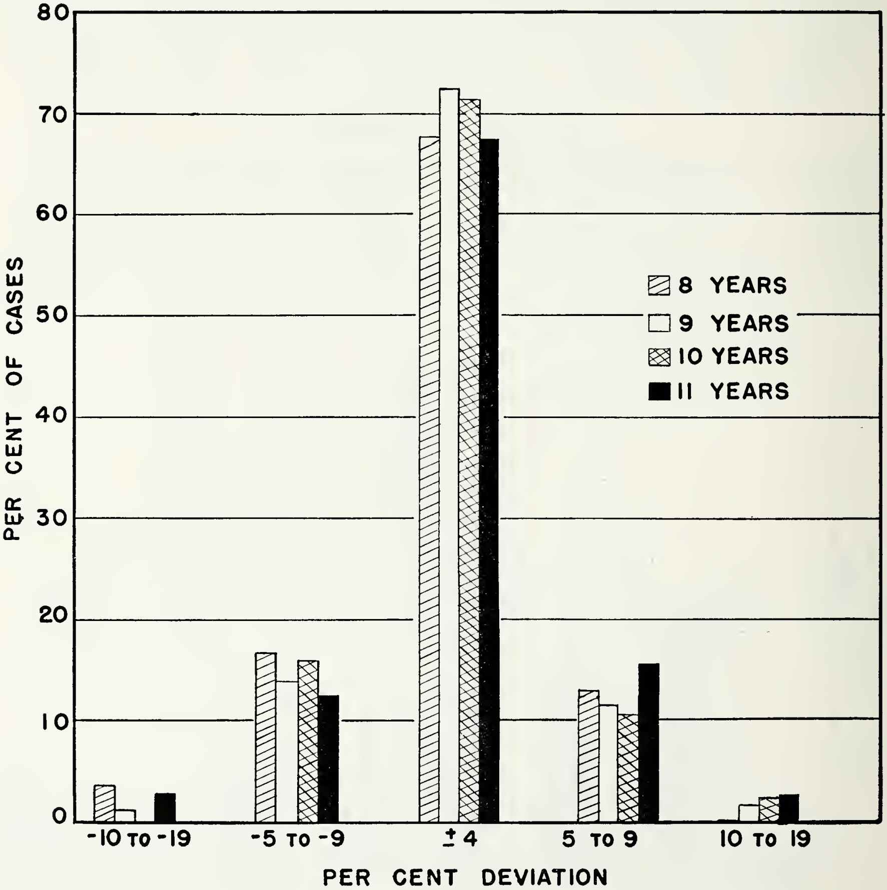

FIGURE 6: PERCENTAGE HEIGHT DEVIATION FROM BALDWIN-WOOD AGE-HEIGHT STANDARDS.

relation was statistically significant at the .01 level. The children were also classified according to age and weight deviation with mean daily calorie intake. No consistent trend was noted. For adults, there is a definite relationship between body weight and calorie needs, but for preadolescent children the calorie needs for growth are not necessarily related to the body size at the moment (14). An undersized child may need relatively more calories than is indicated by size alone if he is to achieve a better rate of growth and eventually attain the proper size.

Stature was measured to the nearest tenth of a centimeter using the Iowa Child Welfare Research Station measuring scale. The height of each child was compared with the Baldwin-Wood Standard for height, weight, and age (3) to determine the level of deviation. For these age groups, the heights given in the Baldwin-Wood Table are the same for both sexes (Figure 6). According to this standard, 70 per cent of the 487 children were within the normal, ±·4 per cent, level of deviation. Approximately 16 per cent were 5 to 20 per cent less than the standard, and approximately 14 per cent measured 5 to 20 per cent higher than the standard.

Although there is no appreciable difference in height for girls reported in the Baldwin-Wood and Meredith-Boynton (26, 8) standards, height for boys is considerably greater in the Meredith standards. From several thousands of measurements on 1,243 males and 1,241 females in

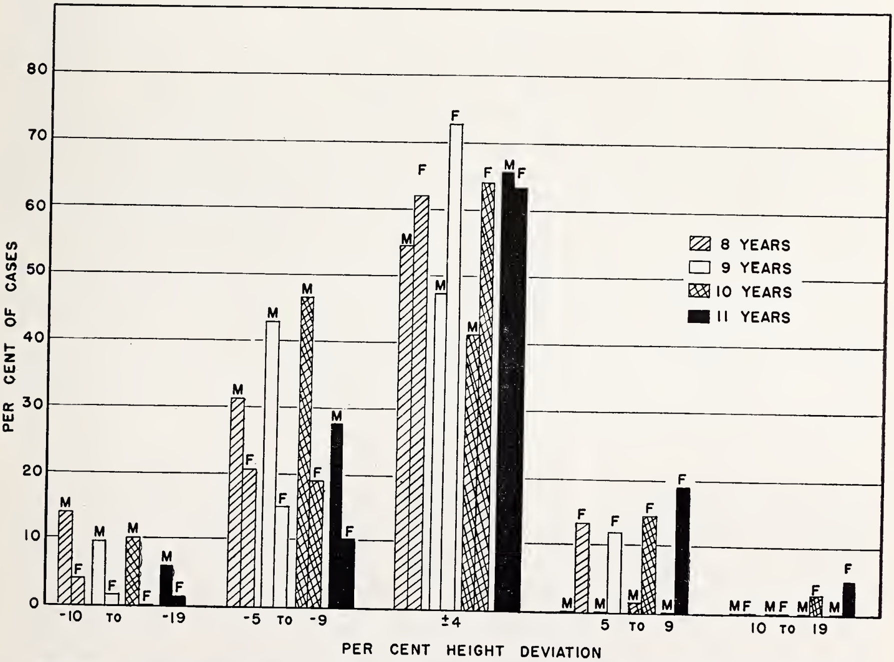

FIGURE 7: PERCENTAGE HEIGHT DEVIATION FROM MERIDITH-BOYNTON STANDARDS ACCORDING TO SEX AND AGE.

Iowa City from birth to eighteen years of age, Meredith (26) and Boynton (8) concluded that boys are taller than girls from three months to ten years. The heights of the 246 boys and 241 girls in the present study were thus compared with these standards (Figure 7). Including all ages, 52 per cent of the boys were of normal height. Except for one case, the remaining 48 per cent measured 5 to 19 per cent less than the standard. Of the total number of girls, 66 per cent were of normal height. Equal numbers, 16 per cent, were from 5 to 19 per cent above and below the standard.

Biochemical Analyses

Hemoglobin, serum vitamin A, serum carotene, and serum ascorbic acid were determined for preadolescent children using the microchemical techniques developed by Bessey and Lowry (4).

Free-flowing blood was obtained by finger-puncture with a Bard-Parker blade. Samples for hemoglobin determinations were diluted with 0.2 per cent ammonium hydroxide, mixed, and placed immediately in an ice chest for transportation to the laboratory. The blood for the other analyses was collected in 3 mm. capillary tubes, sealed with Pyseal, refrigerated, and transported to the laboratory.

The analysis for hemoglobin was completed within two to nine hours after the blood samples were taken. The capillary tubes were centrifuged within two to nine hours after the blood was obtained, and the serum for the vitamin A and carotene analyses was frozen until the determinations could be completed (2 to 3 days). Samples for ascorbic acid analysis were stored overnight under refrigeration in the form of the supernatant obtained from trichloroacetic acid precipitation.

Determinations were made of all four blood constituents at a one-week interval for 351 of the 487 children. For all 487 children, the ascorbic acid value reported is an average of two determinations, both being done in duplicate and each of two technicians analyzing one of the duplicates. Analyses for the other blood constituents were repeated for 351 of the children and an average of the values of both determinations is reported. For the remaining 136 subjects, the values are based on a single determination and the values reported represent an average of duplicates whenever the quantity of blood obtained permitted duplication. Throughout the study the same technician made all hemoglobin analyses, and another technician made all vitamin A and carotene analyses.

Hemoglobin was determined as alkaline hematin (Lowry, 19) reading the samples at 541 mu in a Beckman Spectrophotometer. Serum vitamin A and serum carotene were determined according to the method of Bessey, Lowry, Brock, and Lopez (6). The vitamin A was determined by measurement of the absorption at 328 mu before and after irradiation with ultraviolet light of 310-400 mu; and the carotene was determined by measurement of the absorption at 460 millimicrons. Serum ascorbic acid was analyzed by the method of Lowry, Lopez, and Bessey (20) as modified by Bessey, Lowry, and Brock (5). This method is a microadaptation of the Roe and Kuether (29) dinitrophenylhydrazine procedure for determining total ascorbic acid.

Hemoglobin—The hemoglobin values ranged from 9 to 15 gm. per cent with a mean value of 12.8 ± 0.99 per cent (Table 13). The means ranged from 12.5 gm. per cent for the eight year olds to 13.0 gm. per cent for the eleven year olds, and ranged among schools from 12.1 gm. per cent at Woodlawn to 13.4 gm. per cent at Crescent. The difference between the means of either the age groups or the schools is so slight that it is of no practical importance. Classified according to the Bessey and Lowry levels of nutrition (Table 16), over 50 per cent of the nine, ten and eleven years olds had hemoglobin values which were "good," 12 gm. per cent of hemoglobin or above. Thirty-five per cent of the eight year olds met this standard.

TABLE 13. Range and Mean Values for Blood Hemoglobin of 487 Preadolescent Children Classified According to Age and School

	No. of Subjects	Hemoglobin, gm. %		
		Mean	Std. Dev.	Range
Total	487	12.8	0.99	9.4-15.2
Age: 8	110	12.5	0.99	9.4-14.8
9	123	12.9	0.90	10.2-15.1
10	132	12.8	1.00	10.3-15.2
11	122	13.0	0.99	10.2-15.0
School:				
Crescent	70	13.4	0.70	11.8-15.2
Plaquemine	27	13.0	0.91	10.1-14.2
Covington	100	13.0	0.82	10.2-15.0
Highland	66	12.3	0.82	10.2-14.0
Woodlawn	51	12.1	0.84	10.4-14.0
Gentilly Terrace	111	12.8	0.87	10.6-15.0
Bossier	62	12.8	1.40	9.4-15.2

There is no accepted standard of normalcy for hemoglobin values for children of this age. The standard of 13 gm. per cent as suggested by Bessey and Lowry is probably high. Pett and Ogilvie (28) and Metcoff *et al* (25) considered 12 gm. per cent and above as adequate, and as judged by this standard slightly over 80 per cent of the children in this study had adequate hemoglobin levels. On this basis, therefore, it would appear that a minimum number of the children studied were either borderline or deficient in regard to hemoglobin.

When compared to other studies, similar percentages of Louisiana children fell within the various hemoglobin levels as did those reported by Williams (39) and McBee (23), Table 17. Fewer of the Louisiana children ranked in the highest level than did those studied by Kaucher (17) or Storvick (33), but both of these latter studies included older children, which may account for higher hemoglobin levels. Velat (38) showed a much smaller percentage of children with hemoglobin values of 13 gm. per cent and above than found in this group of Louisiana children. Only 4 per cent of the children had hemoglobin values below 11 gm. per cent, which compares quite closely to the 1 to 6 per cent reported (38, 17, 33, 39, 23).

Vitamin A and Carotene—Serum vitamin A values ranged from 0 to 91 mcg. per cent, with a mean value of 38 ± 10 mcg. per cent (Table 14). Serum carotene ranged from 23 to 414 mcg. per cent, averaging 124 ± 45 mcg. per cent.

As with the hemoglobin values, the differences between the means of serum vitamin A and serum carotene for the age groups and the schools is of no practical importance. Among the age groups the means for serum vitamin A ranged from 36 mcg. per cent for the eight year olds to 39 mcg. per cent for the nine year olds, and the serum carotene values from 114 mcg. per cent for the ten year olds to 135 mcg. per cent for the nine year olds. Among schools the children at Bossier had the lowest mean serum vitamin A value of 33 mcg. per cent and children at Highland the highest with 41 mcg. per cent. Mean serum carotene values ranged from 106 mcg. per cent at Covington to 151 mcg. per cent at Highland.

TABLE 14. Range and Mean Values for Serum Vitamin A and Serum Carotene of 487 Preadolescent Children Classified According to Age and School

		Serum Vitamin A, mcg. %			Serum Carotene, mcg. %		
	No. of Subjects	Mean	Std. Dev.	Range	Mean	Std. Dev.	Range
Total	487	37.9	10.2	0.0-91.1	124	45	23-414
Age: 8	110	35.9	8.9	16.4-65.6	127	50	23-414
9	123	39.1	7.6	15.6-91.1	135	47	52-331
10	132	37.1	10.2	3.6-78.6	114	49	45-216
11	122	38.4	10.9	0.0-73.4	122	43	49-232
School:							
Crescent	70	39.9	13.0	15.6-78.6	124	35	70-216
Plaquemine	27	37.9	10.7	3.6-56.3	119	35	60-196
Covington	100	39.0	4.4	17.4-58.7	106	32	51-212
Highland	66	41.1	8.1	25.0-60.0	151	35	74-217
Woodlawn	51	34.3	8.7	22.4-63.2	139	19	41-414
Gentilly Terrace	111	37.2	10.2	16.4-91.1	128	45	23-290
Bossier	62	32.7	10.4	0.0-49.2	111	43	45-265

Classified into levels of nutrition, 79 per cent of the children rated "good" (30 mcg. per cent and above) for serum vitamin A and 45 per cent rated "good" (125 mcg. per cent and above) for serum carotene (Table 16). For both of these nutrients there was found a greater percentage in this group and fewer in the "poor" group than was reported in the studies reviewed (38, 29, 33, 39). Since the importance of serum carotene in the blood has not as yet been clearly defined, the lower percentage meeting the "good" level for serum carotene as compared with the percentage meeting the "good" level for serum vitamin A may not in itself be an indication of poor nutrition.

A statistically significant positive correlation coefficient of 0.36 was observed between the values for serum vitamin A and serum carotene.

Over 45 per cent of all the subjects had serum carotene values of 125 mcg. per cent or above, and 88 per cent of these, or 40 per cent of the total number of subjects, also had serum vitamin A values of 30 mcg. per cent or above. Likewise, of the 386 subjects which had serum vitamin A values of 30 mcg. or above, only 27 cases, or 6 per cent of the total number of subjects, had serum carotene values below 75 mcg. per cent. Because of the conflicting reports in the literature concerning the relationship of these two blood constituents, more work is necessary before it can be definitely stated whether this apparent correlation is real or merely due to chance alone.

Ascorbic Acid—Serum ascorbic acid values ranged from 0.1 to 2.4 mg. per cent, with a mean value of 0.8 ± 0.5 mg. per cent (Table 15). No difference was found between the averages for the age groups. The children in Plaquemine, Covington, Woodlawn, and Bossier had lower ascorbic acid values than the children in Crescent, Highland, and Gentilly Terrace, with Covington having the lowest value and Crescent the highest. The children at Crescent school regularly received grapefruit juice, and in most cases had consumed some just prior to the time blood samples were taken. This probably at least partially explains the higher mean value for these children.

Table 16 shows that 54 per cent of the children were classified as "good," having serum ascorbic acid levels of 0.6 mg. per cent and above. Although the percentage of subjects in the "good" range compares quite favorably with the other nutrients, a much larger proportion of subjects (30 per cent) had values of serum ascorbic acid in the "poor" range, than for any of the other three constituents. Moyer (27), Storvick (33) and Williams (39), all reported greater percentages of children in the "good" range, and proportionately fewer in the "poor" group. Velat *et al* (38) obtained data quite comparable to this study, with about 50 per cent of the subjects within the "good" range and 29 per cent classed as "poor" (Table 17).

TABLE 15. Range and Mean Values for Serum Ascorbic Acid of 487 Preadolescents Classified According to Age and School

	No. of Subjects	Serum Ascorbic Acid, mg. %		
		Mean	Std. Dev.	Range
Total	487	0.8	0.5	0.1-2.4
Age: 8	110	0.7	0.1	0.1-2.2
9	123	0.8	0.5	0.1-2.4
10	132	0.8	0.5	0.1-2.2
11	122	0.8	0.5	0.1-2.2
School:				
Crescent	70	1.3	0.5	0.1-2.2
Plaquemine	27	0.6	0.5	0.2-2.1
Covington	100	0.5	0.4	0.1-1.8
Highland	66	1.0	0.5	0.2-1.3
Woodlawn	51	0.6	0.3	0.2-1.3
Gentilly Terrace	111	0.9	0.5	0.1-2.4
Bossier	62	0.6	0.4	0.1-1.8

TABLE 16. Children Classified According to Levels of Nutrition as Indicated by Blood Hemoglobin, and Serum Vitamin A, Carotene and Ascorbic Acid

Blood Constituent	Level of Nutrition[1] Unit/100 ml.	Age in Years									
		8		9		10		11		8-11	
		No. of cases	Per cent	No. of cases	Per cent	No. of cases	Per cent	No. of cases	Per cent	No. of cases	Per cent
Hemoglobin, gm.											
Good:	13.0 and above	38	34.5	62	50.4	68	51.5	66	54.1	234	48.1
Fair:	11.0 to 12.9	64	58.2	60	48.8	57	43.2	52	42.6	233	47.8
Poor:	10.9 and below	8	7.3	1	0.8	7	5.3	4	3.3	20	4.1
Serum Vitamin A, mcg.											
Good:	30.0 and above	89	80.9	92	74.8	107	81.1	98	80.3	386	79.2
Fair:	20.0 to 29.9	20	18.2	27	22.0	21	15.9	22	18.0	90	18.5
Poor:	19.9 and below	1	0.9	4	3.2	4	3.0	2	1.6	11	2.3
Serum Carotene, mcg.											
Good:	125 and above	55	50.0	70	56.9	45	34.1	51	41.8	221	45.4
Fair:	75 to 124	44	40.0	44	35.8	68	51.5	54	44.3	210	43.1
Poor:	74 and below	11	10.0	9	7.3	19	14.4	17	13.9	56	11.5
Serum Ascorbic Acid, mg.											
Good:	0.60 and above	59	53.6	71	57.7	69	52.3	64	52.5	263	54.0
Fair:	0.40 to 0.59	15	13.6	21	17.1	23	17.4	21	17.2	80	16.4
Poor:	0.39 and below	36	32.7	31	25.2	40	30.3	37	30.3	144	29.6

[1] Based on ratings of Bessey and Lowry (Meals for Millions, 4).

TABLE 17. Comparison of Five Studies as to the Percentage of Cases at Various Levels of Blood Hemoglobin, and Serum Vitamin A, Carotene and Ascorbic Acid[1]

Reference	Age, Years	Hemoglobin, gm. %				Vitamin A, mcg. %				Carotene				Ascorbic Acid, mg. %			
		No. of cases	13.0 & above	11.0 to 12.9	10.9 & below	No. of cases	30.0 & above	20.0 to 29.9	19.9 & below	No. of cases	Good	Fair	Poor	No. of cases	0.60 & above	0.40 to 0.59	0.39 & below
			% of cases				% of cases				% of cases				% of cases		
Childrens' Fund[3] (17,27,29,36)	3-18	537	67	32	1	452	63	28	9	457	33	54	13	518	84	10	6
McBee, et al (23)	8-13	515	51	45	4	----Not determined----				----Not determined----				----Not determined----			
Storvick et al[4] (33)	14-16		Determined at different levels[4]			723	63	24	13	751	28	51	22	762	59	22	19
Velat et al[3] (38)	6-12	1210	22	72	6	----Not determined----				938	33	47	20	1112	50	21	29
Williams et al[3] (39)	7-12	164	47	52	1	161	60	27	13	164	13	47	40	161	93	6	1
L.S.U. This Study	8-11	487	48	48	4	487	79	19	2	487	45	43	12	487	54	16	30

[1] Levels of nutrition as suggested by Bessey and Lowry (4).

[2] Due to data being presented in different intervals, carotene values were rated in mcg./100 ml. as follows:

	"good"	"fair"	"poor"
L. S. U. and Storvick et al (33)	125 & above	75-124	74 & below
Childrens' Fund (29)	above 140	80-140	below 80
Velat et al (38)	130 & above	70-129	69 & below
Williams et al (39)	130 & above	80-129	79 & below

[3] Recalculated from the data presented.

[4] Hemoglobin data omitted because the higher values in each level for the older boys on this study does not present a similar population group for comparison.

In the entire group of 487 children, 45 per cent or more met the "good" level for each of the four biochemical measurements. With the exception of serum ascorbic acid, just a small percentage of children were in the "poor" level. For hemoglobin, only 4 per cent were in this group, 2 per cent for serum vitamin A, and 12 per cent for serum carotene. Thirty per cent of the children were classed as "poor" in regard to serum ascorbic acid.

Clinical Observations

Observations were made by the examining physicians for lesions of the exposed parts of the body, including the mouth, which have been attributed to nutritional deficiencies. The criteria of abnormality used were those set up by Dr. Goldsmith for use in assessing nutritional status. The lesions were recorded as to degree of severity: none, slight, moderate, and marked. Table 18 gives the percentages of the 487 children with these clinical manifestations in their various degrees of severity.

It is recognized that physical signs of malnutrition may be nonspecific. Absence of any one of several nutritional factors may cause the same clinical lesion, or a similar change may result from injury or disease unrelated to nutritive failure. Conservative interpretation of data is essential because normal variability is so great and clinical examinations are extremely subjective.

Hair, staring—Dry, coarse, and lustreless hair is a common accompaniment of malnutrition. Oftentimes in man, however, its recognition is made difficult because of differences in care of the hair, as in shampooing, use of hair lotions, and brushing. Staring hair was found in only 6 per cent of these preadolescent children.

Skin, facial—Of the manifestations of the facial skin, nasolabial seborrhea was most prevalent, occurring in 18 per cent of the cases. Folliculosis, which is probably related to vitamin A deficiency, was recorded in 7 per cent of the examinations. Less than 4 per cent of the children had other facial manifestations.

Skin, general—Follicular keratosis, bluish-red mottling, and dryness and scaling were the most prevalent general skin lesions. More than 20 per cent of the children had follicular keratosis and bluish-red mottling of the skin. Dryness and scaling of the skin was noticed in 12 per cent of the children. Vitamin A deficiency is usually associated with these lesions.

Eyes—Marked abnormalities of the eyes were not observed in these preadolescent children. Thickened conjunctiva and conjunctival injection were the two lesions most prevalent, with more than 15 per cent of the children having each lesion. Circumcorneal injection was present in five per cent of the cases. The cause of thickened conjunctiva is unknown, but in 1944 in Newfoundland a significant correlation was demonstrated in the five to ten year age group between serum vitamin A and this lesion. Sydenstricker *et al* (35) have stated that circumcorneal injection is the earliest and most common sign of riboflavin deficiency.

TABLE 18. Clinical Manifestations of Nutrient Deficiencies for 487 Louisiana Boys and Girls

Signs and Symptoms	Degree of Severity			
	None	Slight	Moderate	Marked
	%	%	%	%
Hair, Staring	93.6	5.5	0.4	0.4
Skin, Facial:				
Seborrhea nasolabial	81.5	17.2	1.2	0.0
Seborrhea, other	96.9	2.7	0.2	0.2
Folliculosis	92.8	6.6	0.2	0.4
Acne	96.7	2.9	0.4	0.0
Dryness	99.8	0.2	0.0	0.0
Pallor	98.4	1.6	0.0	0.0
Skin, General:				
Dryness & scaling	87.7	11.9	0.4	0.0
Crackled skin	99.6	0.4	0.0	0.0
Follicular keratosis	75.9	19.7	3.5	0.8
Perifolliculosis	97.1	2.7	0.2	0.0
Acniform eruption	99.8	0.2	0.0	0.0
Thick. Pign. pressure points	95.1	4.7	0.2	0.0
Purpura and Petechia	99.8	0.2	0.0	0.0
Pellagraform dermatitis	99.6	0.4	0.0	0.0
Bluish red mottling	78.9	16.2	4.5	0.4
Eyes:				
Photophobia	99.2	0.8	0.0	0.0
Blapharitis	97.7	2.3	0.0	0.0
Follicular conjunctivitis	96.1	3.9	0.0	0.0
Thickened conjunctiva	84.2	13.8	2.1	0.0
Conjunctival injection	84.8	14.2	1.0	0.0
Circumcorneal injection	95.1	4.7	0.2	0.0
Lips and Mouth:				
Angular lesions	98.2	1.2	0.6	0.0
Angular scars	93.2	6.2	0.4	0.2
Cheilosis	67.8	24.8	4.9	2.5
Pallor	98.9	1.0	0.2	0.0
Ulcers of the mouth	99.6	0.4	0.0	0.0
Tongue:				
Papillary hypertrophy	59.8	31.4	8.2	0.6
Papillary atrophy	89.7	9.4	0.8	0.0
Patchy denuded areas	98.9	0.8	0.0	0.2
Red tip or sides	72.3	24.4	3.3	0.0
Purplish or magenta	96.7	3.1	0.2	0.0
Fissures	94.9	3.7	1.0	0.4
Serrations or swellings	99.8	0.2	0.0	0.0
Erosions or ulcers	99.6	0.4	0.0	0.0
Gums:				
Marginal redness	85.4	10.9	3.5	0.2
Marginal swelling	75.9	21.4	2.7	0.0
Atrophy of papillae	99.6	0.2	0.2	0.0
Recession with debris	82.1	14.4	3.3	0.2
Bleeding	97.9	1.6	0.2	0.2
Thyroid:				
Enlarged	98.4	1.6	0.0	0.0

Continued

TABLE 18. Clinical Manifestations of Nutrient Deficiencies for 487 Louisiana Boys and Girls (*continued*)

Signs and Symptoms	Degree of Severity			
	None	Slight	Moderate	Marked
	%	%	%	%
Skeletal:				
Frontal or parietal bosses	72.5	17.0	9.9	0.6
Protruberant abdomen	69.8	22.8	7.2	0.2
Harrison's groove	87.7	11.3	1.0	0.0
Knock knees	75.6	16.8	6.6	1.0
Bowlegs	94.7	3.9	1.4	0.0
Enlarged wrists	99.6	0.4	0.0	0.0
Enl. costochondral junctions	87.5	11.1	1.4	0.0
Flaring ribs	77.8	18.5	3.5	0.2
Winged scapula	34.7	27.5	25.5	12.3
Deformities of the sternum	97.7	1.8	0.4	0.0
Poor posture	77.5	22.5	0.0	0.0
Neuromuscular:				
Calf tenderness	99.8	0.2	0.0	0.0

Signs & Symptoms	Number Affected								
	0	1	2	3	4	5	6	7	8 or more
Teeth:									
Carious	44.1	14.6	11.7	10.3	8.0	5.7	2.9	2.1	0.6
Filled	54.4	10.1	10.3	8.8	6.2	3.1	5.3	0.4	1.4
Missing	64.3	13.9	10.7	4.7	3.9	1.2	0.6	0.0	0.6

Lips and mouth—Angular lesions, angular scars, and cheilosis have been produced experimentally in man from a riboflavin deficient diet. Two per cent of the preadolescents had angular lesions and 7 per cent had angular scars. The prevalence of cheilosis was greater; 3 per cent of the children had marked cheilosis, 5 per cent moderate, and 25 per cent slight. The high percentage of cheilosis in the mild grade is questioned because of the ease with which it may be confused with ordinary chapping of the lips.

Tongue—Observations were made for linqual lesions corresponding to those which develop on patients suffering from a deficiency of niacin. Papillary hypertrophy was noted in 40 per cent of the examinations and papillary atrophy in 10 per cent. The tongue had a red tip or sides in 28 per cent and fissures in 5 per cent of the cases.

Gums—Certain lesions of the gums which have been attributed to ascorbic acid deficiency were noted. Marginal redness and recession of the gums were each found in 15 per cent of the children, and marginal swelling was observed in 24 per cent of the cases.

Thyroid—Enlarged thyroids were found in only 2 per cent of the children. This result was anticipated since the presence of goiter has been reported as characteristically low in Louisiana and other coastal areas.

Skeletal—Signs of early malnutrition were apparent among a large percentage of the children. Evidence of past rickets in mild or major form was indicated by the fact that 27 per cent of the children had frontal or parietal bosses, 30 per cent had protruberant abdomens, 12 per cent Harrison's groove, and 22 per cent flaring ribs. Malformations of the skeletal structure of the legs was shown by the prevalence of knock knees and bowlegs, 24 per cent and 5 per cent, respectively. Winged scapula, the most prevalent skeletal abnormality, was found in 65 per cent of the cases. This condition might have resulted from two things, rickets and/or poor posture. Poor posture was recorded for 23 per cent of 417 of the children. Posture was not recorded at Crescent, but the medical staff later commented regarding the extremely poor posture of these children.

Neuromuscular—Calf-tenderness, the neuromuscular symptom observed, was found very infrequently. Only 0.2 per cent of the children had this sign.

Teeth—There was a high incidence of carious, filled, and missing teeth among these preadolescent children. Fifty-six per cent of the children had 1 or more carious teeth and 1 per cent had 8 or more. Forty-six per cent of the children had 1 or more filled teeth and 5 per cent had as many as 6. Thirty-six per cent of the children had 1 or more missing teeth and 1 per cent had 8 or more. No distinction was made, however, between deciduous and permanent teeth. It would be expected that for children of this age most of the missing teeth would be deciduous.

The percentage of children with each clinical manifestation was grouped according to age. No differences were observed among the eight, nine, ten, and eleven year olds regarding the prevalence of any of the clinical manifestations.

Percentage distribution for each clinical manifestation according to school showed considerable differences between schools, but no consistent trend was noted. General skin lesions, dryness and scaling, were observed in 29 per cent of the Bossier children, 18 per cent of the Gentilly Terrace children and 15 per cent of the Crescent children. These manifestations were less prevalent in other schools. With the exception of Highland, the percentage of children who had follicular keratosis ranged from 15 per cent at Woodlawn to 41 per cent at Plaquemine. Five per cent of the Highland children had this symptom. Incidence of bluish-red mottling was high, 22 to 43 per cent, at all schools except Highland and Woodlawn. Less than 6 per cent of the children of these two schools exhibited this clinical sign.

Follicular conjunctivitis was found to the largest extent among the children at Plaquemine and Crescent, 22 and 16 per cent, respectively. Thickened conjunctiva was observed in 34 per cent of the Covington children, 33 per cent of the Crescent children, and 30 per cent of the Plaquemine children. From 20 to 25 per cent of the children at Crescent, Plaquemine, Covington, and Woodlawn had conjunctival injection. Sixteen per cent of the Crescent children had circumcorneal injection.

The general skin and eye lesions which have been most prevalent in certain schools are usually associated with vitamin A deficiency. It is noteworthy that Plaquemine, the school with the lowest vitamin A dietary intake, had high percentages of children who exhibited multiple lesions generally associated with vitamin A deficiency, namely, follicular keratosis, bluish-red mottling, follicular conjunctivitis, thickened conjunctiva, and conjunctival injection. Particularly low were the intakes of the ten and eleven year old children from this school which averaged approximately 1000 I. U. vitamin A below the recommended allowance.

Certain lesions of the skin and mouth generally attributed to vitamin B complex deficiencies were prevalent in many of the schools. Cheilosis, the most prevalent of the skin and mouth lesions, was observed in more than 20 per cent of the children at every school. Seventy-three per cent of the Bossier children had this manifestation, as did more than 40 per cent of the Plaquemine and Crescent children. This lesion could easily have been confused with chapped lips, however, because the children were examined during cold weather. All schools, except Plaquemine, showed a prevalence of 10 per cent or more of nasolabial seborrhea. Highland and Woodlawn had the highest incidence with 27 per cent of the children exhibiting this skin change. The most prevalent lingual lesion was papillary hypertrophy. With the exception of Plaquemine, more than 30 per cent of the children at every school had this manifestation. Fifty per cent of the children at Bossier had tongues with a red tip and/or sides, and except for Plaquemine this symptom occurred in more than 20 per cent of the children of all schools.

Gum changes were much more prevalent in some schools than in others. Twenty-nine per cent of the Crescent children and 22 per cent of the Covington children had marginal redness. Prevalence in other schools did not exceed 15 per cent. Marginal swelling was observed in 47 per cent of the Crescent children, 35 per cent of those at Covington, and 26 per cent at Plaquemine. At other schools the percentage ranged from 10 to 20. Thirty-two per cent of the Bossier children, 30 per cent of the Crescent children, and 21 per cent of the Covington children had gum recessions. Fifteen per cent or less of the children in the other schools exhibited this clinical symptom.

These high incidences of gum manifestations in certain schools, such as Crescent and Covington, would probably indicate a deficiency of ascorbic acid. The ascorbic acid intake and blood ascorbic acid values of the Crescent children were very good because of the grapefruit juice which the children received at school. It had been stated that the diets of these children had previously been low in ascorbic acid. The increased intake of the vitamin in grapefruit juice had not been for a long enough period of time to relieve the clinical symptoms of deficiency. Blood values of this nutrient, however, increase very rapidly after supplementation.

Wide variations existed among the schools in regard to the percentage of children with carious, filled, and missing teeth. Lack of dental attention was evident in certain schools, especially Crescent and Plaquemine, as seen from the high percentages of carious teeth and the low percentages of filled teeth. At present, lack of sufficient knowledge makes it impossible to assess the extent to which dietary habits are responsible for tooth decay (11, 12).

Skeletal abnormalities were prevalent in all schools; yet there were wide variations among the schools. Bossier always ranked first or second, and Crescent was one of the first three schools having the greatest percentage of children with each manifestation. Highland had the smallest percentage of children exhibiting skeletal signs of early malnutrition.

Interrelationships of Measurements

In evaluating nutritional status, correlation coefficients were calculated to determine relationships between dietary intakes, biochemical tests, and clinical signs and symptoms. Negative correlations resulted in the computations involving clinical data since dietary intakes and blood levels are actual values whereas 0, 1, 2, and 3 were used to represent increasing clinical sign of the deficiency.

Hemoglobin showed a highly significant correlation coefficient of 0.64 with iron intake. When correlated with the protein intake the coefficient was 0.03, which was not significant.

Vitamin A value of the diet was correlated with the serum vitamin A, serum carotene, and serum ascorbic acid. The clinical evaluation of bluish-red mottling of the skin; follicular conjunctivitis and thickened conjunctiva of the eyes; and combined evaluation of dryness and scaling, follicular keratosis and follicular conjunctivitis, and thickened conjunctiva were each correlated with the dietary vitamin A value, serum vitamin A, and serum carotene.

Vitamin A value of the diet appeared to be related to the serum vitamin A, with a statistically significant correlation coefficient of 0.77. A correlation coefficient of 0.14 was found between the vitamin A value of the diet and serum carotene; and a coefficient of 0.25 was found between the vitamin A value of the diet and serum ascorbic acid. Although statistically significant, these latter correlations are of little or no practical importance.

No correlation was found between bluish-red mottling of the skin; follicular conjunctivitis and thickened conjunctiva; and the combined symptoms of dryness and scaling of the skin, follicular keratosis, follicular conjunctivitis, and thickened conjunctiva, and vitamin A value of the diet.

Though the correlations are too low to be of practical importance, with decreased serum vitamin A and serum carotene there was a statistically significant increase in the appearance of bluish-red mottling as shown by correlation coefficients of -0.14 with serum vitamin A and -0.13 with serum carotene. No correlation was found between the other symptoms that have been associated with vitamin A deficiency and the vitamin A and carotene blood values. Adamson *et al* (1) in a Newfoundland survey found a significant correlation between serum vitamin A levels and excess tissue in the conjunctivae in children six to ten years of age; however, no correlation was observed between other physical signs and the concentration of vitamin A in the serum. Krause *et al* (18) found no difference in vitamin A concentration in the blood of children with and without follicular keratosis, but carotene values were lower when folliculosis was present. Numerous other studies have failed to show any correlation between the level of vitamin A in the blood and thickening of the conjunctiva (18, 31, 34) and other presumed physical evidences of vitamin A deficiency (42).

A statistically significant correlation coefficient of 0.45 was shown between the ascorbic acid intake and serum ascorbic acid values. When the data for the Crescent children were omitted from the study, a statistically significant correlation coefficient of 0.41 was found between the ascorbic acid intake and serum ascorbic acid levels (9).

For the entire group of 487 children there was no correlation between the clinical evaluation of the gum changes of marginal redness and bleeding, and either the ascorbic acid intake or serum ascorbic acid. This lack of any relationship between gum changes and ascorbic acid intake or ascorbic acid blood levels confirms previous reports (10, 13, 16, 19) on the nonspecificity of these clinical manifestations. If the data from Crescent are omitted, however, a positive association exists between the serum levels of ascorbic acid and the gum changes (9). The omission of the Crescent data is believed to be valid because these children were given extra quantities of grapefruit juice in the morning shortly before blood samples were taken; and, under these circumstances, the serum ascorbic acid levels were not indicative of their true ascorbic acid status.

Decreased riboflavin intake appeared to be related to increased manifestation of angular lesions and scars of the lips with a correlation coefficient of -0.12. Likewise statistically significant at the .01 level but of little or no practical importance was the association of riboflavin intake with the combined symptoms of angular lesions and scars, cheilosis, papillary changes, patchy denuded areas, and purplish and magenta tongues, and seborrhea and folliculosis with a correlation coefficient of -0.20. None of these latter symptoms singly correlated with riboflavin intake.

No significant correlations were observed between niacin intake and angular lesions and scars of the lips, or between papillary changes and patchy denuded areas and red tips and sides of the tongue, or between these symptoms combined.

Low but statistically significant correlations were observed between decreased protein intake and occurrence of angular lesions and scars of the lip, and papillary hypertrophy or atrophy and patchy denuded areas of the tongue. The coefficients were -0.12 and -0.26, respectively.

Many of these clinical signs and symptoms have been reported to occur as a result of deficiencies, but owing to the subjective means of measurement they appear to be unreliable means for detecting subclinical deficiencies of any single nutrient (24, 34, 40, 41).

SUMMARY

A survey of 487 Louisiana school children between the ages of eight and eleven was conducted to determine their dietary intakes and their nutritional status in regard to height and weight, blood nutrient levels, and clinical manifestations of nutritional deficiencies.

Forty-three per cent of the children had calorie intakes greater than 10 per cent above the National Research Council's allowance. Twenty-nine per cent of the children met the allowance within 10 per cent. Twenty-eight per cent consumed less than 90 per cent of the allowance for calories.

More than 60 per cent of the children met the recommended allowance for all nutrients except ascorbic acid. With the exception of ascorbic acid, less than 10 per cent failed to meet two-thirds of the allowances. Generally, fewer of the ten and eleven year olds met the allowances than did the eight and nine year olds.

Thirty-one per cent of the children were of normal weight, 48 per cent were more than 5 per cent underweight, and 22 per cent were more than 5 per cent overweight.

According to Baldwin-Wood age-height standards, 70 per cent of the children were normal, 16 per cent shorter, and 14 per cent were taller than normal. Compared to the Meredith standards for boys, about one-half of the boys were below standard height. There was no difference between these two standards in regard to height for girls.

Ninety-five per cent of the children had hemoglobin values of 11 gm. per cent or above, and of these, 48 per cent were above 13 gm. per cent. Serum vitamin A was above 20 mcg. per cent in 95 per cent of the children; 79 per cent were above 30 mcg. per cent. Serum carotene in 89 per cent of the children was above 75 mcg. per cent, with 45 per cent above 125 mcg. per cent. Seventy per cent of the children had ascorbic acid serum levels of 0.4 mg. per cent or above, and of these, 54 per cent were above 0.6 mg. per cent.

Clinical manifestations which occurred to the extent of 20 per cent or more of the children were: follicular keratosis and bluish-red mottling of the skin; cheilosis, papillary hypertrophy and red tip or sides of the tongue; marginal swelling of the gums; and the skeletal changes of frontal or parietal bosses, protruberant abdomen, knock knees, flaring ribs, winged scapula, and poor posture.

There was a direct relationship between the vitamin A value intake and the serum levels of vitamin A and carotene; and between the ascorbic acid intake and serum ascorbic acid. A significant positive correlation was observed between iron intake and hemoglobin concentration. Less clear cut was the relationship between the clinical manifestations and the nutrient intakes or blood levels. In some instances these correlations were significant statistically, but more often they were not.

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Protein in Rice as Influenced By Variety and Fertilizer Levels

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PROTEIN IN RICE AS INFLUENCED BY VARIETY AND FERTILIZER LEVELS

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Rice is one of the important cereals produced in Louisiana. In spite of its almost world-wide production and use only scattered and incomplete data are available on the amount and nature of the proteins it contains. No information is at hand, furthermore, on the genetic factors involved in protein content and composition of the various varieties. A large amount of data is available on the relation of soil type and fertilization to yields of rice, but no systematic study has been made on the effect of these factors upon protein content.

The International Rice Festival of 1950 featured rice as the most versatile of all foods. Certainly it is the most extensively grown food crop in the world. The total annual world production is approximately 3.3 billion 100-pound bags (27). Of this total, the United States produces somewhat over one per cent, of which 11 million bags is Louisiana's part. Louisiana produces 33 per cent of the American crop on 550 thousand acres and sells its production of rough rice for approximately 50 million dollars.

Rough rice is made up of approximately 21 per cent hulls and 79 per cent grain or hulled seed. The hulled seed contains from 6.4 to 9.4 per cent protein. The average is about 7.4 per cent because of increases in acreages in the low protein varieties such as Zenith, Bluebonnet, and Magnolia. Rexoro and Blue Rose are higher in protein, but of these varieties only Rexoro continues to hold up in acreage being planted. The generally recognized tables of Morrison's Feeds and Feeding give rough rice a protein content of 8.3 per cent and polished or milled rice a protein content of 7.4 per cent. The marketable protein of the Louisiana rice crop at present amounts to approximately 78 million pounds annually. If the average protein content were raised 1.0 per cent this would add approximately 10 million pounds of protein to Louisiana's production. When one considers the fact that Louisiana is producing approximately 41 million pounds of protein in beef while it is producing 78 million pounds in rice and that the beef protein sold for 45 million dollars while the rice proteins sold for approximately 3.8 million, it is very obvious that rice will continue to be in economic demand. Of course, not many Americans if given a free choice would substitute rice protein for beef protein, but this has been done largely in countries of low income levels, particularly in the Orient. The fact that it has been done for thousands of years argues for the quality of rice protein. It also suggests that possibly where rice makes up a large part of the daily diet primitive people without any scientific knowledge may have selected rice varieties of good protein content. Americans, on the other hand, in their all-out effort to breed crops for higher yields may be paying insufficient attention to protein quantity and quality. This has been done in hybrid corn breeding. Although rice is primarily a carbohydrate crop, one cannot overlook the fact that protein in rice sells from the farm for 5 cents per pound while it sells from the farm for 50 cents per pound in meats. It is also a fact that rice contains all the essential amino acids for growth and maintenance in man (16). Is it without some significance that Rexoro, the rice variety most in demand by the American consumers, is a high protein rice?

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The purposes of this study have been (a) to determine the variation in protein content of certain varieties and new selections now being grown at the Louisiana Rice Experiment Station, (b) to determine the variations in protein distribution in solubility fractions as related to variety or new genetic selections, and (c) to determine the effects of different fertilizer levels on protein production.

REVIEW OF LITERATURE

Although rice (*Oryza sativa*) ranks first in production among the grain crops of the world, its study is greatly in need of organization. Compared with the proteins of wheat, corn and barley, those of rice have been but little studied. Unlike the proteins of other cereals, a greater percentage of the proteins of rice belong to the rather uncommon class of proteins called glutelins. A large portion of the data in the literature on rice has been concerned with the total alkali-soluble proteins. The protein of rice soluble only in dilute alkali was first isolated by Rosenheim and Kajiura (38) in 1908 and named oryzenin. Based on solubility, there are four types of proteins in rice (52). They are water-soluble albumin, salt-soluble globulin, alcohol-soluble prolamin, and dilute-alkali-soluble glutelin.

Rice contains less protein than the other top-ranking cereal grains, wheat and corn. When, however, the proteins of rice, wheat and corn were compared in feeding studies at the same level of intake, rice protein had a higher biological value than the proteins of wheat or corn (44). Sure and House (46) determined by the nitrogen-balance method the relative biological values of proteins in cererals fed at a 5 per cent protein level. The protein utilization for the milled cereal grains was: rice 75.1, wheat 60.0, rye 63.1, and corn 32.0, with 100 as a basis of comparison. The findings for the whole grain were: rice 80.0, wheat 76.1, rye 73.2, corn 78.8, and rolled oats 75.6. Mitchell (26) also found that the biological value of brown rice protein was superior to that of corn or oats on the same level of intake (5 per cent). Workers at the Connecticut Agricultural Experiment Station (32) compared rice protein with the protein of wheat and maize and found that the rice proteins yielded relatively high amounts of the basic amino acids: arginine, histidine, and lysine, and comparatively little ammonia and non-amino nitrogen.

Price (36) determined arginine, lysine and valine contents of four different varieties of wheat by microbiological methods. Results indicated that the wheat lowest in total nitrogen contained a higher proportion of these amino acids than varieties highest in nitrogen. This suggests qualitative as well as quantitative differences in protein content of wheat varieties.

In its general amino acid make-up, rice protein more closely resembles the majority of animal proteins than do those of wheat or maize. This may explain the extensive use of rice as an almost exclusive diet for millions of people in the Orient in spite of its low protein content.

Block and Bolling (4) have reported the following values in per cent for the different amino acids in rice protein: arginine 7.2, lysine 3.2, tyrosine 5.6, tryptophane 1.3, histidine 1.5, isoleucine 5.1, phenylalanine 6.3, cystine 1.4, methionine 3.4, threonine 3.9, leucine 9.0, and valine 6.4. The biological value of a protein seems to depend, in general, upon the contents of these dietary essential amino acids.

The protein content of rice varies from 6.0 to 9.0 per cent and is affected by many factors including genetic variety. The hope and belief that the protein content of rice might be increased considerably by proper breeding is worthy of serious consideration. Seeds of closely related species resemble each other in the character and proportions of the several different forms of proteins which they contain, e.g., the seeds of cereals are the only ones containing proteins soluble in strong alcohol (30). Therefore, since little work has been reported on variation of protein content with different rice varieties, it is pertinent to review the work that has been reported on variation of other grain proteins with variety.

In a study of the influence of heredity on protein content of wheat, Shutt (43) found significant differences in the averages of protein contents of 165 samples, representing 45 varieties.

Multiple factor inheritance of crude protein content was indicated from crosses among three varieties of wheat (53). Clark (6) also working on breeding wheat for higher protein content showed that the inheritance of crude protein content is as complex as that of yield, and that environment is fully as important in determining the result in one case as in the other. Strains with a crude protein content higher than that of the better parent were not obtained. These inheritance studies indicated that the total amount of crude protein per acre, however, may be increased through improvement in yield with maintenance of the crude protein content of the highest parent. To increase the crude protein content of the grain materially it appears necessary to select a high protein parent even at a sacrifice in yield.

Using 15 corn hybrids and varieties grown at two nitrogen levels in

1946 and 18 hybrids at three nitrogen levels in 1947, Viets and Domingo (50) showed significant differences in nitrogen content and yields.

Miller, Aurand, and Flach (25) analyzed nine different single crosses of inbred lines of yellow corn for lysine, tryptophane, and methionine. Individual replicates of these varied in crude protein content from 8.48 to 14.13 per cent. Amounts of each of the amino acids studied varied directly with the crude protein content; consequently, the quality of the protein as measured by these amino acids was not changed within the range of protein covered.

With studies of inheritance in some summer and winter wheat crosses of the F_4, F_5, and F_6 generations Swen (47) showed that the protein content was inheritable but strongly influenced by weather and soil conditions. In several crosses, Swen found that the protein content of the progeny actually was as much as 1.4 per cent greater than that of the highest parent. He found no complete relation between protein content and yield of grain.

Investigations on the separation by solubility of the proteins of rice and other seeds give evidence that the protein fractions vary with the variety and with the total protein content.

Sadasivan and Sreenivasan (40) found, on analyzing rice varieties having different morphological characteristics, that colored and coarse-grained varieties of rice usually contain greater percentages of protein and minerals than do the fine-grained varieties. Sreenivasan also (44) reported that the poor quality of rice as ordinarily consumed in India is largely traceable to the choice of the wrong varieties as well as to the refining processes. He conducted a rat-feeding study on six varieties of Indian rice and found that the gain in weight was considerably different for the different varieties. It was also shown that the same percentage of rice protein from two different varieties caused significant differences in rate of growth, thus showing that the quality as well as the quantity of protein in rice varies with variety.

Basu and Basak (3) observed that the two most common varieties of Indian rice, Aman and Aus, were different in nitrogen distribution and solubility fractions as indicated:

	Water Extract	5% NaCl Extract	75% Alcohol Extract	0.4% Alkali Extract	Total Recovery %
Aman	5.8	22.6	3.7	62.7	94.8
Aus	7.5	29.2	3.0	55.7	95.4

The globulins (salt-soluble) and the glutelins (alkali-soluble) of both varieties were analyzed by the Van Slyke method and were found to differ in nitrogen distribution. The Aman rice contained more sulfur-containing amino acids and more arginine than the Aus rice.

Using the procedure devised by Csonka (8), Kik (20) analyzed the proteins of rice and rice by-products by extracting with four solvents:

1 per cent sodium chloride, 60 per cent alcohol, 0.1 per cent alkali, and an acid alcohol mixture. The distribution for the different rice samples was as follows:

Solvent	Whole rice %	White rice %	Rice from S treated plot %	Rice from Check plot %
1% NaCl	13.81	11.50	16.20	14.53
60% alcohol	3.66	5.75	4.00	3.00
0.1% alkali	44.22	40.85	40.60	40.00
acid alcohol	3.98	5.33	4.70	3.70
residue	25.90	27.60	28.50	32.23
% Nitrogen Extracted	91.58	90.50	93.40	93.23

The relative amounts of the different proteins in high- and low-protein corn were studied by Miller, Aurand, and Flach (25), and it was indicated that a considerably larger part of the protein is present as glutelins and globulins in high-nitrogen corn than in low-nitrogen corn, and that these had been formed at the expense of the amides and albumins. He found also that the glutelin fraction varied the most from the high- to the low-protein corn. The quantity of the various proteins was correlated with the total nitrogen content.

Anderson and Ayre (1) showed that the distribution of nitrogen in barley is influenced by variety. They found that at any given total nitrogen content, the proportions of each protein fraction may differ from one variety to another. Within and between varieties there was a highly significant positive correlation between alcohol-soluble protein nitrogen and total nitrogen. With increasing total nitrogen the proportion of salt-soluble fraction decreased, the alcohol-soluble increased, and the insoluble fraction remained relatively constant. The insoluble fraction was defined as that protein not soluble in salt or alcohol solutions.

It has been found that the extraction of albumins and globulins of barley is most satisfactory with 5.0-6.5 per cent K_2SO_4 or 7 per cent NaCl (21). Urion, Lejeune, and Collin (49) found that concentrations higher than the above-mentioned extracted a small part of the gluteline. None of the salt solutions extracted any of the prolamins, but the extraction of this alcohol-soluble fraction was made easier by first extracting the barley with saline solution. Osborne (31) also concluded from his data on barley and wheat flours that alcohol extractions should be preceded by a saline extraction since alcohol will dissolve part of the albumins and globulins.

During ripening of rice the total nitrogen content was shown by Tadokoro and Abe (48) to exhibit no definite tendency to change, but the ratio of protein to non-protein nitrogen increased constantly. The water-soluble group decreased and the salt-soluble was inconsistent in its changes. The rice samples were harvested at four weekly intervals, the last harvest consisting of completely ripe samples.

The average farmer is usually more interested in the yields of his crop than the quality of the product, and he therefore uses a top-dressing of nitrogen fertilizer to increase the yield. There is ample evidence that increased yields alone do not represent the full and true value of nitrogen fertilizer for small grain crops. Experimental results are reported in which nitrogen fertilizer increased the protein content of small grain from 12 to 55 per cent. In general, protein content cannot be increased much over 25 per cent without decreasing the yield; also if stands are too thick, yields are increased at the expense of protein. Earley and De Turk (10) present evidence that points to the conclusion that the application of enough nitrogen to produce maximum yields of corn will also assure a higher protein content if the rate of planting is limited.

It is, of course, generally recognized that the composition of a crop is affected by the fertility of the soil. From a practical standpoint, however, it is not enough to know that such a relationship exists. Quantitative information must be available if the crop growers are to be properly guided in their fertilizer programs and farming operations. How much change in the composition of crops which can be brought about by fertilizer or increases in soil fertility must be known. One must know also how changes in plant composition are related to increase in crop yield. Information on these problems in connection with wheat, barley and oats emphasizes the fact that the changes in the protein content of small grain are related to the increase in crop yields resulting from fertilization.

Pierre (35) found that, in general, the greater the increase in yield from a given amount of nitrogen fertilizer the less is the change in protein content of the crop. The corollary is likewise true. When the soil is very deficient in nitrogen and when the amount of nitrogen fertilizer added is small or insufficient to obtain maximum yields, most or all of the nitrogen absorbed by the plant is utilized in increasing yields. In some cases, the percentage protein is actually lowered, because the crop utilizes the small amount of nitrogen added during early growth. During the latter part of the season, therefore, when the grain is forming, less nitrogen is available in relation to the needs of the crop than where no nitrogen is applied. At the other extreme are the soils that are already well supplied with nitrogen or to which large amounts of nitrogen fertilizer are added in relation to the needs of the crop. In some cases luxury consumption results. The plant continues to take up nitrogen beyond normal requirements, and since little or none of it is used for increased carbohydrate yield the protein percentage in the plant increases but the total yield is low.

A situation encountered quite often in fertilizer practice involves a soil quite deficient in nitrogen and where the amount of nitrogen added is about sufficient to meet the needs of the crop and to produce maximum or near maximum yields. Under such conditions one usually gets both an increase in crop yields and an increase in the protein content of the crop. The increases in protein content and grain, however, are usually small and in the order of 10 to 25 per cent.

Many investigations have been designed to demonstrate the effect of available nitrogen on the protein content of various crops. The performance of complete fertilizers, potash and phosphoric acid have also been considered.

The effect of nitrogen fertilizer on the yield and protein content of wheat varieties was reported by Peterson (34). In some cases the fertilizer is utilized in increasing the yield and hence there is no material difference in the protein content of the grain. He found that only the early applications of nitrogen induced significant increases in protein content. When an effect was obtained, a heavier nitrogen application induced a greater percentage protein and a greater yield.

Mosolov (28) found that early and medium maturing wheat varieties compared with late maturing varieties used relatively small quantities of nutrients and utilized these more effectively for the formation of grain of high protein content. Nitrogen and phosphoric acid when applied to the early and medium maturing varieties helped avoid early aging of leaves and of the plant as a whole.

Increases in protein content of corn of 7.8 to 9.4 per cent in a dry year and of 5.5 to 8.2 per cent in a wet year through nitrogen fertilization on a poor soil were reported by Kohnke and Vestal (22). They found that corn from an inherently more fertile soil had a higher protein content and caused more growth in a hog-feeding test than corn from an inherently poor but highly fertilized soil. Viets and Domingo (50) also found that the protein content of corn could be appreciably increased by the use of nitrogen fertilizer. Even on loamy sand the recovery of fertilizer in the grain was 48 per cent of the nitrogen applied.

Gardiner (11) found that with several varieties of wheat whose protein content varied from 9.6 to 10 per cent and averaged 9.9 per cent the increased protein content due to 150 pounds per acre of ammonium sulfate top-dressing averaged 0.36 per cent. He found the average recovery of the applied nitrogen was 26 per cent in the grain.

The addition of mineral nitrogen increases the yield and protein content of crops under favorable conditions. The effectiveness of the mineral nitrogen as a fertilizer, however, depends on seasonal and soil conditions and on the amounts of nitrogen applied. In order to obtain the best response, nitrogen fertilizer must be balanced with the proper amounts of phosphorus and potassium.

Plot trials were conducted by Schmitt and Schineis (41) to determine the increase in protein content of grain effected by a late application of nitrogen fertilizer. The grains tested were barley, oats, and spring wheat. It was found that the addition of sodium nitrate just before heading caused a marked increase in percentage of protein when compared with samples from plots for which all the nitrogen was added at the time of seeding.

Selke (42) conducted field experiments as well as pot experiments for four years to prove the value of nitrogen applied at a late stage in growth to increase the nitrogen content of the common grains as well as yields and quality. He showed that the increased nitrogen was present as protein in the grain. He also found that the degree of effectiveness of the late top-dressing was dependent upon the moisture supply and that the application should follow a good rain.

That the percentage of nitrogen in wheat was higher when the soil had received a nitrogenous fertilizer and that it increased with the quantity of nitrogen added was demonstrated by Demolon (9).

McCalla and Woodford (24) and also Ginsberg (12) reported that limiting the supply of potassium for wheat plants grown with an otherwise complete fertilizer resulted in a decreased nitrogen content. Reduced potassium supply also resulted in an increase in the proportion of grain to total yield which was partially caused by retarded growth. Byczkowski and Jarmusz (5) reported that increase in potassium fertilizer together with a moderate supply of nitrogen exerted no influence on the content of nitrogen in barley. With a higher nitrogen supply, however, an application of potassium lowered the nitrogen content of the grain. Joret and Malterre (19), furthermore, related that the nitrogen content of wheat underwent very slight change with increasing doses of potassium in the presence of a fixed amount of nitrogen. It has been reported by Hibbard and Grigsby (14) that increasing the potassium fertilizer applied to grain had no effect on the nitrogen content.

Reitz and Myers (37) found that the application of superphosphate fertilization on wheat increased yields of grain and straw and decreased the percentage of protein. Nehring (29) reported that added phosphate had a beneficial effect only if the water supply was adequate. The phosphate decreased the nitrogen content but increased the yield so that the over-all effect was to increase the protein yield.

The protein content of rice can be increased by as much as 20 per cent by suitable fertilization up to the time of flowering of the plants, according to Sadasivan and Sreenivasan (40).

Annotel (2) showed that calcium phosphate applied to rice fields gave a marked increase in the protein content of the grain.

The protein content was highest from the nitrogen and complete fertilizer plots. High protein was associated with low carbohydrate content. Field experiments with rice receiving different fertilizer treatments including ammonium sulfate, calcium phosphate, and potassium chloride individually and as a complete mixture were described by Pain (33).

In a controlled study of rice in pots, Sturgis and Reed (45) found that the yield of rice on a nitrogen deficient soil could be increased 25 per cent by use of complete fertilizer. The increase in the protein content was only 10 per cent. The protein content of rice on a naturally fertile soil was 39 per cent higher than on a deficient soil.

Studies on the effects of increasing the nitrogen supply on yields and composition of corn, rice and wheat have been reported by Russell (39). If the nitrogen fertilizer greatly stimulates crop growth, the nitrogen content expressed as percentage of dry weight will often decrease although the total yield increases. This is because the extra growth which the added nitrogen stimulates the plant to produce has lower nitrogen or protein content than that produced by a nitrogen starved crop. As the level of nitrogen supply increases, the stimulation on total growth becomes smaller so the uptake of fertilizer nitrogen is increasing relative to the additional production resulting from it. The nitrogen content of the crop begins to rise, but only becomes large when the growth of the crop ceases to respond economically to the additional fertilizer. The effect of added nitrogen on protein content is most effective when applied near harvest. The reaction of rice was found to be intermediate between corn and wheat.

MATERIALS AND METHODS

I. Materials

Rice grown in two different years was used to determine the effects of various fertilizer levels on protein production. The rice was grown at the Rice Experiment Station, Crowley, Louisiana, on Crowley silt loam soil. Nitrogen fertilizer was applied as ammonium nitrate, which is 32 per cent nitrogen; phosphorous as superphosphate or calcium phosphate, which is 20 per cent P_2O_5; and potassium as potassium chloride, which is 50 per cent K_2O. These three fertilizer factors were varied

TABLE I

Fertilizer Treatments for 1949 and 1950

1949	1950	
N-P_2O_5-K_2O	N-P_2O_5-K_2O	N-P_2O_5-K_2O
lbs./A.	lbs./A.	lbs./A.
0-0-0	0-0-0	20-20-40
0-18-12	0-0-20	20-40-0
0-36-24	0-0-40	20-40-20
0-54-36	0-20-0	20-40-40
12-18-12	0-20-20	40-0-0
24-36-24	0-20-40	40-0-20
36-54-36	0-40-0	40-0-40
18-18-12	0-40-20	40-20-0
36-36-24	0-40-40	40-20-20
54-54-36	20-0-0	40-20-40
	20-0-20	40-40-0
	20-0-40	40-40-20
	20-20-0	40-40-40
	20-20-20	

to determine their effects individually and in different combinations. The fertilizer was applied at time of seeding with a seed and grain drill. This method of application has been found to increase the effectiveness of the fertilizer by effecting a better weed control and a closer contact of the rice plant roots and fertilizer (51). In Table I the fertilizer levels are listed for both years.

The 1949 fertilizer treatments were replicated three times; the protein yields were determined separately for the three replicates. In 1950 the replicates were combined and analyses were made on one representative sample for each fertilizer level. The yield values reported for the 1950 rice samples are averages for all replicates grown for each treatment.

TABLE II

Characteristics of Varieties and Selections

Sample No.	Variety or Selection	Avg. Date Maturity	Hull Color	Pubescence	Ease of Threshing	Grain Type*	Table Quality**
47	Zenith	8/24	straw	hairy	Dif.	M.	M.S.
37	Bluebonnet	9/9	straw	smooth	easy	L.S.	F.
50	Dwarf Texas Patna	9/18	gold	smooth	easy	L.	F.
38	322A6-23	9/13	straw	hairy	easy	M.L.	F.
51	Lacrosse	9/16	straw	smooth	Dif.	M.	S.
32	Arkrose	9/16	straw	hairy	Dif.	M.	S.
31	Magnolia	8/23	straw	smooth	easy	M.L.	F
62	Nira	9/18	straw	smooth	easy	L.L.	F.
42	3I-9-2-4	10/1	straw	smooth	Dif.	M.	S.
36	Century	8/31	gold	smooth	easy	L.	-***
35	Fortuna	9/14	straw	hairy	easy	L.L.	F.
59	7/8 Rexoro	10/9	gold	smooth	Dif.	L.S.	F.
58	4II-1-8	9/9	straw	smooth	easy	L.S.	F.
61	3-72-3	10/2	gold	smooth	easy	M.L.	F
39	Prelude	9/2	straw	hairy	Dif.	L.L.	S.
43	Caloro	9/8	straw	hairy	Dif.	P.	S.
44	Improved Blue Rose	9/24	straw	hairy	Dif.	M.	S.
34	7/8 Rexoro-3-12	10/11	gold	smooth	Dif.	L.L.	F.
60	Purple Bran	-***	straw	smooth	-***	M.	-***
33	6I-25-12	10/4	straw	hairy	easy	M.	S.
56	Rex-Nira	9/18	gold	smooth	-***	M.	S.
46	Rexoro x Purple Leaf	10/2	gold	smooth	easy	M.L.	F.
41	Rexoro-Delitus	10/5	gold	smooth	easy	L.	Sc.
52	4II-4-1-4	10/5	straw	smooth	Dif.	L.S.	-***
54	15/16 Rexoro-3-22	10/11	gold	smooth	easy	L.S.	F.
45	Blue Rose 41	9/24	straw	hairy	Dif.	M.	S.
57	7/8 Rexoro-3-22	10/9	gold	smooth	Dif.	L.S.	F.
55	Texas Patna x Rexoro	10/5	gold	smooth	easy	L.L.	F.
40	Rexoro	10/11	gold	smooth	easy	L.S.	F.

*M.—medium, M.L.—medium long, L.—long, L.L.—large long, L.S.—long slender P.—pearl.
**F.—flaky, S.—sticky, M.S.—medium sticky, Sc.—scented.
***No data available.

To determine the variation in protein content of certain varieties and new selections, and to determine the variation in protein distribution in five solubility fractions as related to variety or new genetic selections, twenty-nine varieties and new selections were analyzed for total protein nitrogen, water-soluble albumin, salt-soluble globulin, alcohol-soluble prolamin, alkali-soluble glutelin, and residual or insoluble protein. All varieties and selections were grown under the same soil and seasonal conditions. The varieties and their characteristics are shown in Table II.

II. Methods

A. Preparation of Rice Samples

Air-dried rough rice samples were hulled by means of a Smith shelling device as approved by the U.S.D.A., Production and Marketing Administration, Grain Branch. The hulled rice grains were then separated from the loose hulls by means of a Bates laboratory aspirator. This method was consistent in that each time 50 grams of rough rice were hulled and separated, approximately 9.7 grams of hulls and 39.3 grams of grains were obtained. A Wiley mill was used to grind the hulled grain to pass through a 20-mesh sieve. Rice samples for all analyses were prepared in this manner. Moisture determinations were made on all samples. The macro-Kjeldahl method was used for the determination of protein in the residue and total protein content of all samples. Proteins of the varieties and selections were fractionated by extracting with four solvents: distilled water, 5 per cent sodium chloride, 70 per cent ethyl alcohol, and 0.2 per cent sodium hydroxide. Micro-Kjeldahl determinations were run on these four fractions.

B. Protein Separation

The mthod for protein fractionation is a modified combination of the methods reported by Csonka (8) and by Lund and Sandstorm (23). Modifications made were shown by experimental verification to give the most reliable results.

Five grams (5.0000) of ground rice were weighed into a 500-ml Erlenmeyer flask. The rice was defatted by three half-hour extractions with 25 to 30 ml of dry diethyl ether. The extractions were carried out by allowing the sample to stand in the ether for 30 minutes with occasional shaking. After 30 minutes the ether was decanted, and the sample was extracted with another 25 to 30 ml of ether. After the third ether extraction, the sample was left unstopped for a short time so that the ether which could not be decanted would evaporate.

The first protein that was separated from the rice was the water-soluble albumin. Albumins were extracted by three water extractions of 30 to 50 ml of distilled water each. Two of the extractions were for one hour and the third was overnight. After the sample had remained in the water for the desired length of time, the sample was filtered on Whatman No. 1 filter paper. Solid material that was caught by the filter paper was washed with the solvent into the 500 ml Erlenmeyer flask containing the sample. After the third extraction the residue was washed with two 10 ml portions of water. The filtrates from the three extractions and the two washings were combined and diluted to volume in a 200 ml volumetric flask. A 50 ml portion of this volume was taken for a micro-Kjeldahl determination for nitrogen.

After the albumin separation the same five-gram rice sample was extracted with 5 per cent sodium chloride to separate the globulin from the rice. The method for the 5 per cent sodium chloride extraction was the same as that for the water extraction.

The filtrates and washings were combined and diluted to 200 ml in a volumetric flask. A 25 ml portion of this volume was taken for a micro-Kjeldahl nitrogen determination.

The residue was extracted next with a 70 per cent ethyl alcohol solution to remove the prolamin, using the same procedure that was used for both water and salt extractions.

The three filtrates and two washings were combined and diluted to 250 ml in a volumetric flask. Fifty ml of this volume was taken for a micro-Kjeldahl nitrogen determination.

The fourth and last extraction was with 0.2 per cent sodium hydroxide to remove the oryzenin or rice glutelin. The extracting, filtering, and washing procedure employed for the three previous extractions was altered only in that there were four extractions with 0.2 per cent sodium hydroxide, three of two hours each and a fourth overnight.

After the second 10 ml washing, all of the residue was washed from the Erlenmeyer flask onto the filter paper with 0.2 per cent sodium hydroxide. This was allowed to filter overnight and was designated as the third washing. The four filtrates and the three washings were diluted to volume in a 500 ml volumetric flask. A 25 ml portion of this volume was used for the micro-Kjeldahl nitrogen determination. The residue on the filter paper was denoted as insoluble protein and was analyzed for nitrogen by the macro-Kjeldahl method.

C. Micro-Kjeldahl Determination

Micro-Kjeldahl determinations were made on all protein solubility fractions of the variety samples. An aliquot of the protein solution was pipetted into a 100 ml Kjeldahl flask. The aliquot used was determined by the anticipated concentration of nitrogen in the fraction being analyzed, i.e., 50 ml of the water and alcohol fractions and 25 ml of the sodium chloride and sodium hydroxide fractions. One gram of nitrogen-free potassium sulfate and five drops of 5 per cent cupric sulfate were added to the sample in the Kjeldahl flask. Two ml of concentrated sulfuric acid (sp. gr. 1.84) were pipetted into the flask, and lastly, a glass bead was put in the flask to facilitate boiling and to prevent bumping.

The flask containing the sample was heated gently over a Bunsen burner to evaporate most of the solution. When the contents of the flask were concentrated to 15 to 20 ml, the heat was increased and the heating was continued a few minutes after all carbonaceous material was digested and only the clear green solution remained. The flasks were cooled to 40-50° C and diluted with 10 ml distilled water while being shaken.

The distillation was carried out with a Pregl type (A. H. Thomas) micro-Kjeldahl steam distillation apparatus. Employing a 125 ml Erlenmeyer flask as a receiver, the ammonia distilled from the samples was caught in 2 ml of standardized 0.1N sulfuric acid and 10 ml of distilled water contained in the receiving flask. The delivery tube into the receiving flask was held below the surface of the liquid in the flask.

The digested contents of the Kjeldahl flask were poured into the distilling flask of the apparatus. Approximately 10 to 15 ml of distilled water were used to rinse the flask and funnel. Eight to ten ml of 50 per cent carbonate-free sodium hydroxide were added to the distilling flask and the sample was steam distilled until approximately 50 ml of distillate were collected. The receiving flask was then disconnected and the delivery tube was rinsed with 3 to 5 ml of distilled water; the rinsings were caught in the receiving flask.

The contents of the receiving flask were quantitatively transferred to a 100 ml volumetric flask and diluted with distilled water to approximately 80 ml. Ten ml of Nessler's reagent, prepared according to directions in Hawk, Oser, and Summerson (13), were added and the flask was filled to the mark with distilled water. The color developed was read in a Beckman DU quartz spectrophotometer at 480 uu wavelength and a slit width of 0.3.

Six standard ammonium chloride solutions were prepared containing 0.1, 0.2, 0.5, 1.0, 1.5 and 2.5 mg. of nitrogen, respectively. Optical density was read after Nesselerization in the Beckman DU spectrophotometer and standard curves were plotted. Milligrams of nitrogen in the rice samples were determined from their corresponding optical densities by means of these standard curves.

D. Macro-Kjeldahl Determinations

Total protein of all samples and insoluble protein of the varieties and selections were determined by the following procedure. The analyses were made on a Precision Scientific Co. Kjeldahl apparatus.

1. **Digestion:** The method consisted of weighing accurately 1.2-1.4 grams of sample onto a sheet of Whatman No. 42 ashless filter paper. The filter paper was carefully folded around the sample so that it could be dropped into an 800 ml Kjeldahl flask allowing none of the sample to touch the neck of the flask. An oxidizing mixture of 15 g of nitrogen-free potassium sulfate, 0.6 to 0.8 g cupric sulfate ($CuSo_4 \bullet 5H_2O$) and 20 ml of concentrated sulfuric acid (sp. gr. 1.84) were added to the Kjeldahl flask in the order stated.

The Kjeldahl flask containing the sample and oxidizing mixture was then placed on the digestion rack. The rheostat was set at 20 to begin the digestion, but when frothing began the heat was increased to maintain a vigorous frothing. The flask was rotated frequently and the heat was carefully controlled to prevent the frothing mixture from entering the neck of the flask. By the end of the digestion the heat had been increased to a full rheostat reading of 100. Heating was continued at full heat for 30 minutes after all the black material had disappeared, i.e., after all carbonaceous material had been digested.

The heat was turned off at the end of 30 minutes and the flask was allowed to cool on the digestion rack to 40°-50° C. After the flask was cooled it was removed from the digestion rack.

The samples were diluted with 250 ml of ammonia-free distilled water. The water was added with shaking of the flask to avoid crystalization of the sample.

2. **Distillation:** Fifty ml of saturated boric acid solution were measured into a 500 ml Erlenmeyer flask employed as a receiving flask. The receiving flask was then connected to the delivery tube of the distillation rack and the water in the condensers was turned on in preparation for the distillation.

When the Kjeldahl flask was cool, 75 ml of 50 per cent carbonate-free sodium hydroxide were added to the flask held at a 30° angle in order that the sodium hydroxide would collect in a layer beneath the sulfuric acid layer. The layers were not allowed to mix. One to two grams of 20-mesh zinc metal were added to the flask, and the flask was quickly connected to the distilling rack. The heat was turned on with the rheostat set at 100. Then with the stopper held firmly in place, the flask was shaken gently until the sulfuric acid layer was neutralized as indicated by the deep blue color of cupric ammonium sulfate. When the sulfuric acid was neutralized, the flask was shaken vigorously to mix completely the two layers. The flask was then put on the burner and the mixture was distilled at a smooth steady rate to collect 100 ml of distillate over a period of 45 to 60 minutes. The receiving flask was disconnected from the delivery tube and the delivery tube was rinsed with 3 to 5 ml of distilled water; rinsings were caught in the receiving flask.

The ammonia in the boric acid was titrated with standardized sulfuric acid (one-tenth normal) using 3 to 4 drops of methyl red as the indicator solution.

E. Moisture Determinations

Moisture content was determined on accurately weighed two-gram samples which were heated to constant weight in an oven at 106° C.

RESULTS AND DISCUSSION

In Tables III through IX, given below, are reported the results of experiments conducted to determine the effects of different fertilizer levels on protein production, and to determine the variation in protein content and protein distribution of certain varieties and new selections now being grown at the Louisiana Rice Experiment Station, Crowley, Louisiana.

Examination of the data in Table III shows that Magnolia rice grown on Crowley silt loam soil treated with 600 pounds of 0-9-6 fertilizer per acre and nitrogen in varying amounts from 12 to 54 pounds responded in growth and yield to all the fertilizer treatments. There was no significant difference in response, however, among the different amounts and kinds of fertilizer. Analysis of the data on the plot basis shows that there were no significant differences in the percentage of

TABLE III

Effect of Fertilizers on Protein Content and Yield of Magnolia Rice on Crowley Silt Loam, at the Rice Experiment Station, Crowley, Louisiana, 1949.

Pounds per A. N-P_2O_5-K_2O	Replicate	Moisture* %	Protein* %	Rough Rice lbs./A.
0-0-0	I	12.84	10.16	1532
0-0-0	II	13.53	10.47	1080
0-0-0	III	12.82	8.54	1066
	Mean		9.72	1226
0-18-12	I	13.44	9.86	2127
0-18-12	II	15.81	9.61	2000
0-18-12	III	13.04	10.06	1422
	Mean		9.84	1849
0-36-24	I	13.61	10.68	2085
0-36-24	II	14.22	10.49	1720
0-36-24	III	12.42	9.96	1377
	Mean		10.38	1727
0-54-36	I	15.64	10.47	1744
0-54-36	II	15.85	10.52	2000
0-54-36	III	15.98	10.50	1468
	Mean		10.49	1737
12-18-12	I	15.56	10.34	1915
12-18-12	II	13.46	9.53	1720
12-18-12	III	12.97	10.19	1489
	Mean		10.02	1708
24-36-24	I	16.05	10.48	1170
24-36-24	II	13.02	9.73	1720
24-36-24	III	15.39	10.64	1867
	Mean		10.28	1586
36-54-36	I	15.67	10.74	1191
36-54-36	II	15.74	9.95	1920
36-54-36	III	13.53	10.31	1889
	Mean		10.33	1666
18-18-12	I	12.66	10.01	2149
18-18-12	II	13.16	9.60	1220
18-18-12	III	13.86	9.88	1489
	Mean		9.83	1619
36-36-24	I	12.17	10.55	2064
36-36-24	II	13.34	9.82	1300
36-36-24	III	14.25	10.20	1156
	Mean		10.19	1507
54-54-36	I	15.63	9.99	1872
54-54-36	II	15.62	10.65	2200
54-54-36	III	15.95	10.28	1133
	Mean		10.31	1735

Percentage Protein is on a dry weight basis. Protein = 6.25 x N.
*Values are averages of duplicate determinations.
F value for percentage protein is 1.02 and is non-significant.

protein obtained from the different treatments including the checks or non-treated replicates. Statistical treatment of the data from each replicate indicates that the apparent differences in protein content were brought about by soil heterogeneity and not by the treatments. Further analysis of the data shows there is no significant correlation between the yield and the protein content. It should be noted, however, that the percentage of protein from the different treatments on Magnolia rice in this experiment is the highest recorded in this study, and that the natural soil conditions were more effective than fertilizer treatments on the influence of the percentage of protein in the rice. The rice in this experiment was planted late and did not mature until November. The late seasonal effects may have contributed to the inordinately high protein content and low yield of the Magnolia variety. Magnolia is normally an early variety. This further suggests that variety and varietal adaptations to season and soil are major factors in determining the percentage of protein in rice.

Data in Table IV indicate that the yield of Bluebonnet rice grown on Crowley silt loam at the Rice Experiment Station in 1950 was in-

TABLE IV

Effect of Fertilizers on Protein Content and Yield of Bluebonnet Rice on Crowley Silt Loam, at the Rice Experiment Station, Crowley, Louisiana, 1950.

Pounds per A. N-P_2O_5-K_2O	Moisture* %	Protein* %	Rough Rice lbs./A.
0-0-0	13.02	7.73	2365
0-0-20	12.44	8.06	2365
0-0-40	12.39	7.84	2511
0-20-0	12.38	7.95	2932
0-20-20	12.83	7.93	2981
0-20-40	11.98	7.64	3110
0-40-0	13.12	8.14	2738
0-40-20	13.13	7.84	2786
0-40-40	13.20	8.14	2786
20-0-0	12.18	7.96	2884
20-0-20	12.50	7.70	2333
20-0-40	12.55	7.68	2835
20-20-0	12.55	7.78	3143
20-20-20	11.94	7.88	3110
20-20-40	12.59	7.59	3353
20-40-0	12.48	7.86	3451
20-40-20	12.35	8.12	3564
20-40-40	12.46	7.83	3256
40-0-0	12.69	8.66	2543
40-0-20	11.61	7.84	2446
40-0-40	12.47	8.26	2745
40-20-0	11.91	7.65	2803
40-20-20	12.08	7.72	3645
40-20-40	12.14	7.56	3661
40-40-0	12.48	7.64	3094
40-40-20	12.00	8.01	3580
40-40-40	12.70	7.53	3094

Percentage protein is on a dry weight basis. Protein = 6.25 x N.

* Values are averages of duplicate determinations.

creased by nitrogen at both the 20 and 40 pounds per acre levels. Yield was further increased by addition of phosphate at both the 20 and 40 pound levels. Higher yields were obtained where both nitrogen and phosphate were used. There was little difference between the response to either nitrogen or phosphate at the 20 and 40 pound levels. Both nitrogen and phosphate were limiting factors on the yield of the rice. The inclusion of potash in the fertilizer mixture did not increase the yield of rice consistently. With nitrogen at the 40 pound level and phosphate at both the 20 and 40 pound levels the 20 pound level of potash did increase yields. With nitrogen at the 40 pound level and with no addition of phosphate the highest percentage protein was obtained. The relationship of a high nitrogen application and high protein with limited phosphate supply could not be measured statistically. It appears

TABLE V

Names and Origins of Varieties and Selections.

Sample No.	Variety or Selection
47	Zenith (Selection from Blue Rose)
37	Bluebonnet (Rexoro x Fortuna)
50	Dwarf Texas Patna (Selection of a natural cross on a dwarf mutation)
38	Selection No. 322A6-23 (Rexoro x Fortuna)
51	Lacrosse (Colussa-Blue Rose x Shoemed-Fortuna)
32	Arkrose (Caloro x Blue Rose)
31	Magnolia (Improved Blue Rose)
62	Nira
42	Selection No. 3I-9-2-4 (Blue Rose-Rexoro x Blue Rose)
36	Century (Selection from Texas Patna x Rexoro-Supreme Blue Rose)
35	Fortuna
59	⅞ Rexoro-3-22 (Selection of Blue Rose-Rexoro x Rexoro x Rexoro)
58	Selection No. 4II-1-8 (Blue Rose-Rexoro x Rexoro)
61	Selection No. 3-72-3 (Rexoro x Purple Leaf)
39	Prelude (Improved Blue Rose x Fortuna)
43	Caloro
44	Improved Blue Rose
34	⅞ Rexoro-3-12 (Rexoro x Blue Rose-Rexoro)
60	Purple Leaf
33	Selection No. 6I-25-12 (Blue Rose-Rexoro x Blue Rose)
56	Rex-Nira (Selection from Rexoro x Nira)
46	Selection No. 3-72-3 (Rexoro x Purple Leaf)
41	B321B40-3 (Selection from Rexoro x Delitus)
52	Selection No. 4II-4-1-11 (Selection from Rexoro x F_I of Rexoro x Blue Rose)
54	15/16 Rexoro-3-22 (Selection from Rexoro x Blue Rose-Rexoro)
45	Blue Rose 41 (Selection from Improved Blue Rose)
57	⅞ Rexoro-3-22
55	Texas Patna x Rexoro

that the high protein may have resulted from an excess of nitrogen due to limitation of growth from phosphate deficiency.

Statistical analysis of the data shows there are significant differences in percentage of protein among the different treatments. The differences are significant at both the 5 per cent and the 1 per cent levels. Because of the fact that the samples were composites from each treatment and not samples from each replicated plot the influence of soil heterogeneity could not be determined and the relationship between treatments could not be established statistically. A correlation coefficient was calculated for the association of yield and percentage protein. It was found to be non-significant, thus showing there was no tendency for the two factors to vary together either in a negative or a positive direction.

TABLE VI

Protein Contents of Varieties and Selections of Rice from the Rice Experiment Station, Crowley, Louisiana, 1950.

Sample No.	Variety or Selection	Protein* Air-Dry Basis %	Moisture* %	Protein* Dry Wt. Basis %
47	Zenith	6.436	12.47	7.375
37	Bluebonnet	6.586	12.97	7.569
50	Dwarf Texas Patna	6.763	12.57	7.738
38	322A6-23	6.869	12.76	7.875
51	Lacrosse	6.983	13.00	7.975
32	Arkrose	7.106	13.15	8.181
31	Magnolia	7.119	13.05	8.188
62	Nira	7.169	12.74	8.213
42	31-9-2-4	7.213	13.02	8.294
36	Century	7.316	12.97	8.400
35	Fortuna	7.325	13.12	8.431
59	7/8 Rexoro	7.375	12.98	8.475
58	4II-1-8	7.394	12.40	8.438
61	3-72-3	7.444	12.55	8.512
39	Prelude	7.488	12.98	8.606
43	Caloro	7.556	12.82	8.669
44	Improved Blue Rose	7.606	12.89	8.731
34	7/8 Rexoro-3-12	7.625	13.32	8.794
60	Purple Bran	7.663	13.03	8.781
33	6I-25-12	7.681	13.09	8.838
56	Rex-Nira	7.813	12.94	8.975
46	Rexoro x Purple Leaf	7.913	12.84	9.081
41	Rexoro-Delitus	7.931	13.26	9.144
52	4II-4-1-4	8.106	13.13	9.331
54	15/16 Rexoro-3-22	8.181	13.05	9.488
45	Blue Rose 41	8.594	12.66	9.838
57	7/8 Rexoro-3-22	8.625	13.13	9.931
55	Texas Patna x Rexoro	8.700	12.74	9.969
40	Rexoro	9.440	13.18	10.825

* Values given are averages of duplicate determinations.

Under the best field conditions and where nitrogen is a limiting factor approximately 2.4 pounds of fertilizer nitrogen must be applied to produce 100 pounds of rough rice (51). Under the conditions of this experiment 40 pounds of nitrogen when applied with phosphate and potash increased the yield of rice approximately 1300 pounds. Only a 1600 pound increase could have been expected. This means that according to the theory of Russell (39), previously referred to, an increase in protein could not have been expected since yields were increasing so that

TABLE VII

The Distribution of Protein Nitrogen in the Varieties and Selections as Shown by Extraction with Different Solvents.

Sample No.*	H_2O-sol. Albumin[1] %	NaCl-sol. Globulin %	Alc.-sol. Prolamin[2] %	NaOH-sol. Glutelin[3] %	Insoluble %	Recovery %
47	9.72	14.06	1.46	35.23	38.55	106.06
37	11.16	7.70	2.07	37.97	41.10	109.96
50	9.96	6.98	1.18	38.68	43.22	94.73
38	9.98	13.96	1.86	35.25	38.97	100.73
51	11.57	15.67	1.80	38.53	31.52	100.07
32	10.11	12.92	0.76	43.31	32.91	104.06
31	9.35	13.29	0.69	43.90	32.79	102.72
62	7.05	12.90	1.26	32.57	46.25	105.51
42	7.91	14.61	1.83	35.74	39.93	100.87
36	9.00	8.81	1.60	34.33	46.27	106.61
35	9.48	12.02	1.75	36.24	40.51	102.56
59	7.79	13.37	1.58	35.51	41.77	94.56
58	7.77	15.43	1.63	32.91	42.77	94.64
61	8.26	12.23	1.85	31.50	46.17	96.00
39	8.36	13.13	2.14	46.65	29.74	107.43
43	9.84	13.48	2.67	49.64	24.48	106.40
44	8.73	14.26	1.42	41.43	34.18	104.63
34	6.77	8.80	2.02	39.39	43.03	103.63
60	7.69	13.77	1.09	38.70	38.76	107.87
33	9 84	13.16	1.62	41.91	33.48	102.91
56	8.10	15.88	1.05	39.66	34.73	97.31
46	6.91	13.27	1.69	34.98	43.12	95.80
41	8.49	11.57	1.58	42.78	35.59	102.44
52	6 07	12.17	1.58	42.57	37.63	105.77
54	6.78	13.60	1.31	39.36	38.96	101.18
45	9.01	10.43	0.70	46.80	33.06	99.16
57	6.58	12.82	1.14	41.39	38.07	100.04
55	7 24	14.24	2.24	38.33	37.98	98.95
40	6.15	11.67	2.27	45.61	35.36	102.55

All values in table are averages of duplicate determinations.

* Sample numbers correspond to those in Table V.

[1] Correlation with total protein $r = -.695$; $^2r = .776$; $^3r = .399$

there was not excessive accumulation of protein in the crop. Had the level of nitrogen applied been far in excess of what normally could have been used by the crop, consistent increases in the percentage of protein could have been expected from the application of excessive amounts of nitrogen. Such increases could be expected to be in the order of 10 to 20 per cent above normal.

Statistical analysis of the nitrogen contents of the more important varieties and selections of rice now being grown in Louisiana shows that there are significant differences in nitrogen or protein contents. Table VI reports the protein contents of samples of the varieties and selections used. The calculated F value is given in Table VIII. It shows that the differences in percentage of nitrogen among the varieties and selections are significant at both the 5 and 1 per cent probability levels. The least significant differences (L.S.D.) required for these two levels of probability are 0.057 and 0.077, respectively.

Examination of the data in Table VII reveals that the average percentage recovery of protein nitrogen for the extractions was 101.96 with a range of 94.56 to 109.96 per cent based on the total nitrogen determinations given in Table VI. Statistical analysis of the nitrogen distribution in the separate fractions shows that there are significant differences among the percentages of the total nitrogen occurring in each fraction for the different varieties and selections. The differences are significant at the 5 per cent and the 1 per cent probability levels as shown by the tabulated F values, Table VIII, determined by an analysis of variance.

TABLE VIII

Results of Statistical Analysis of the Protein Nitrogen Distribution in the Varieties and Selections as Shown by Extraction with Different Solvents.

	F	L.S.D. 5%	L.S.D. 1%	Correlation (r) with Total N
Total Nitrogen	29.01**	0.057	0.077	
Water Fraction	126.71**	1.19	1.61	−0.695**
5% NaCl Fraction	8.55**	2.21	2.97	0.078
70% Ethyl Alcohol Fraction	7.94**	0.48	0.64	0.776**
0.2% NaOH Fraction	17.85**	3.13	4.22	0.399*
Residue	31.52**	2.70	3.64	0.185

* Indicates significance at the 5 per cent probability level.
** Indicates significance at the 1 per cent probability level.

F value calculated to test the significance of differences among means.

L.S.D. Indicates the smallest difference necessary for significance at a particular probability level.

In Table VIII also are the L.S.D. values for the means of the nitrogen distribution in the solubility fractions of the protein.

Correlation coefficients were calculated to determine whether or not any of the solubility fractions were correlated with the total nitrogen. Since the total protein nitrogen content of the samples varied, the nitrogen in the different fractions was reported as a percentage of the total nitrogen content for each sample. By this means the nitrogen in the different fractions could be reported as a comparable basis. The correlation coefficients in Table VIII show that the water-soluble protein nitrogen is negatively associated with total protein nitrogen and that the alcohol-soluble protein nitrogen and dilute-alkali-soluble protein nitrogen are positively associated with the total protein nitrogen. The salt-soluble protein and insoluble protein nitrogen fractions are not correlated with total protein nitrogen. This means that with increasing total nitrogen the water-soluble protein nitrogen decreases while the alcohol-soluble protein nitrogen and the dilute-alkali-soluble protein nitrogen increases. The salt-soluble protein nitrogen and the insoluble protein nitrogen fractions are not definitely related to the total nitrogen or protein content.

TABLE IX

Varieties and Selections of Rice Arranged in the Order of Increasing Protein Nitrogen Content.

Sample No.	Variety or Selection	Total N %	H_2O-sol. % Tot. N	Alc.-sol. % Tot. N	NaOH-sol. % Tot. N
47	Zenith	1.033	9.72	1.46	35.23
37	Bluebonnet	1.054	11.16	2.07	37.97
50	Dwarf Texas Patna	1.082	9.96	1.18	38.68
38	322A6-23	1.099	9.98	1.86	35.25
51	Lacrosse	1.110	11.57	1.80	38.53
32	Arkrose	1.137	10.11	0.76	43.41
31	Magnolia	1.139	9.35	0.69	43.90
62	Nira	1.147	7.05	1.26	32.57
42	3I-9-2-4	1.154	7.91	1.83	35.74
36	Century	1.169	9.00	1.60	34.33
35	Fortuna	1.172	9.48	1.75	36.24
59	7/8 Rexoro	1.180	7.79	1.58	35.51
58	4II-1-8	1.183	7.77	1.63	32.91
61	3-72-3	1.191	8.26	1.85	31.50
39	Prelude	1.198	8.36	2.14	46.65
43	Caloro	1.209	9.84	2.67	49.64
44	Improved Blue Rose	1.217	8.73	1.42	41.43
34	7/8 Rexoro-3-12	1,220	6.77	2.02	39.39
60	Purple Bran	1.226	7.69	1.09	38.70
33	6I-25-12	1.229	9.84	1.62	41.91
56	Rex-Nira	1.250	8.10	1.65	39.66
46	Rexoro x Purple Leaf	1.266	6.91	1.69	34.98
41	Rexoro-Delitus	1.269	8.49	1.58	42.78
52	4II-4-1-4	1.297	6.07	1.58	42.57
54	15/16 Rexoro-3-22	1.309	6.78	1.31	39.36
45	Blue Rose 41	1.375	9.01	0.70	46.80
57	7/8 Rexoro-3-22	1.380	6.58	1.14	41.39
55	Texas Patna x Rexoro	1.392	7.24	2.24	38.33
40	Rexoro	1.504	6.15	2.27	45.61

By arranging the varieties and selections in the increasing order of their protein nitrogen contents, Table IX, and by considering that the varieties must differ from one another by 0.057 per cent protein nitrogen to be significantly different, the varieties and selections can be placed in low protein and high protein groups. These varieties and selections were grown in small plots under the same conditions. The soil was a uniform area of Crowley silt loam at the new Louisiana Rice Experiment Station. The soil is naturally fertile and was not highly fertilized. The differences may be considered as being inherently caused by variety. The Caloro variety with 1.209 per cent protein nitrogen occupies the median position. Zenith, Bluebonnet, Dwarf Texas Patna, 322A6-23, Lacrosse, Arkrose, Magnolia, Nira, 31-9-2-4, Century, and Fortuna are low in protein. Rex-Nira, Rexoro x Purple Leaf, Rexoro-Delitus, 4II-4-1-4, 15/16 Rexoro-3-22, Blue Rose 41, 7/8 Rexoro-3-22, Texas Patna x Rexoro, and Rexoro are in the high protein group. The varieties 7/8 Rexoro, 4II-I-8, 3-72-3, Prelude, Caloro, Improved Blue Rose, 7/8 Rexoro-3-12, Purple Bran, 6I-25-12 occupy a middle group. These are not significantly different from one another in protein nitrogen content, nor are they significantly different from the highest members of the low protein group or the lowest member of the high protein group.

It is particularly interesting to note that Rexoro and Blue Rose 41 are high protein rices and that certain crosses with Rexoro are high in protein. The combinations involving Rexoro and Blue Rose are high in protein. All Rexoro crosses, however, are not high in protein. Some of the outstanding crosses of Rexoro with Fortuna are low in protein. It appears that inheritance of high protein content is, as would be expected, complex and that whether or not a high protein variety can transmit the high protein characteristic depends also on the variety it is being crossed with. The genetic relationships are outside the scope of this study, but the data here does show that the protein contents of the commonly grown varieties vary as much as 50 per cent, which of itself indicates the great importance that the inherent characteristics of a variety play in determining the protein content. It is obvious that of the factors studied varietal inheritance has more to do with determining protein content than do soil conditions or fertilizer treatments.

SUMMARY AND CONCLUSIONS

A study has been made of the effects of fertilizer treatments on the protein content of rice grown on Crowley silt loam, of the variation in protein content of different varieties of rice, and of the distribution of protein fractions within the varieties and new selections now being grown at the Louisiana Rice Experiment Station. The fertilizer experiments were particularly concerned with the relationships between increasing amounts of fertilizer nitrogen and the protein nitrogen content of the rice. The protein content of the different varieties and new selections were determined on rice grown under uniform soil and seasonal conditions. The protein of each variety or selection was fractionated by the use of water, 5 per cent sodium chloride, 70 per cent ethyl alcohol, and 0.2 per cent sodium hydroxide.

Fertilizer treatments, particularly the mixtures containing nitrogen and phosphate, increased the yields of rice but they did not significantly increase the percentage of protein nitrogen.

Differences in the protein nitrogen due to soil heterogeneity were observed.

Factors which limit normal growth or yield, such as late planting and high application of nitrogen fertilizer with a limited available soil phosphorus supply, increased the percentage of protein nitrogen.

On the basis of all treatments there was no significant correlation between percentage protein nitrogen and yield of rice.

Statistical analysis of the protein distribution in the solubility fractions shows that there were differences among the percentages of the total nitrogen occurring in each fraction. Water-soluble protein was negatively correlated with total protein. Alcohol-soluble and alkali-soluble proteins were positively correlated with total protein. Salt-soluble and insoluble proteins were not definitely related to total protein.

The protein contents of the different varieties and selections varied between 6.44 and 9.44 per cent. Zenith occupies the low position, Caloro the median, and Rexoro the high.

Apparently, the inheritance of protein content is complex. Whether or not a high protein variety transmits the high protein characteristic depends also on the variety with which it is crossed. Varietal inheritance has more to do with determining protein content than do soil conditions or fertilizer treatments.

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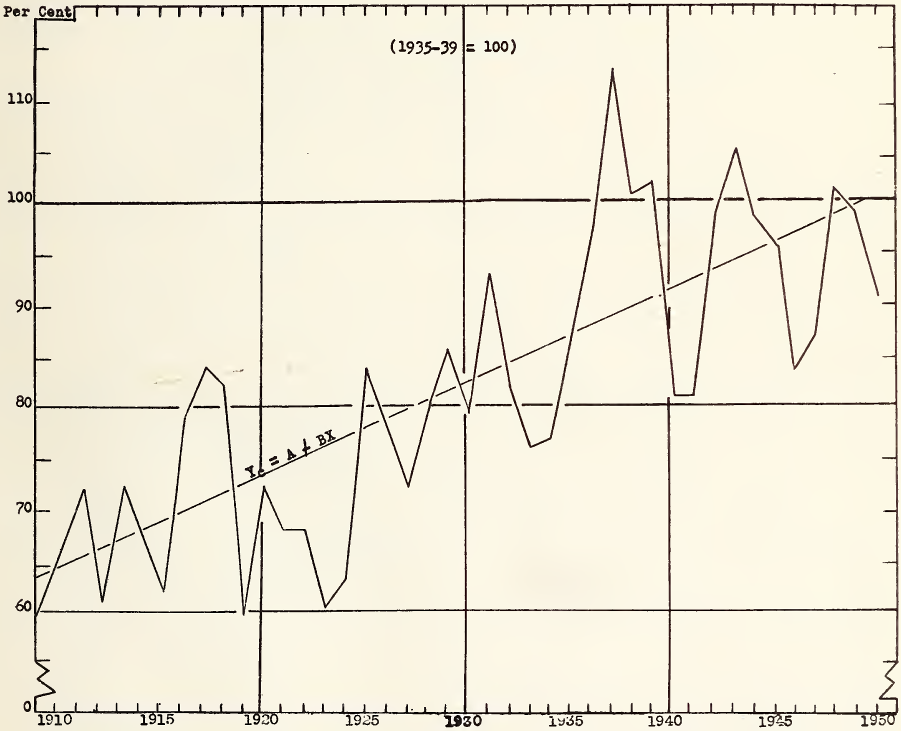
Louisiana Farm Production

1909 - 1951

By

J. P. MONTGOMERY

Composite Index of Volume of Agricultural
Production, Louisiana, 1909-1952
(1935 – 39 = 100)



The volume of agricultural production increased materially but irregularly from 1909 through 1951.

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATION
W. G. TAGGART, Director

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LOUISIANA FARM PRODUCTION

J. P. MONTGOMERY

The half century ending in 1950 was a period of material progress for agriculture in Louisiana. It was marked by a rising volume of total production, increasing efficiency in the utilization of production resources, a shift toward a better balance between farm enterprises, an intensification of operating capital per cropland acre and per worker, and a rising level of living made possible by larger incomes per capita from agricultural production.

This report is limited largely to an analysis of trends in production and the changes that have taken place in the relative importance of the major crop and livestock enterprises. The summary analyses will serve to give perspective to general agricultural conditions in Louisiana and should be of value to farmers in planning for further progress in agriculture.

Table 1. - Numbers and size of farms in Louisiana, 1910-1950

Census period	Number of Farms	Farm land (Acres)		Cropland (Acres)	
		Total	Average per farm	Total	Average per farm
1900	115,969	11,059,127	95.4	4,666,532	40.2
1910	120,546	10,439,481	86.6	5,276,016	43.8
1920	135,463	10,019,822	74.0	5,626,226	41.5
1925	132,450	8,837,502	66.7	5,064,031	38.2
1930	161,445	9,355,437	57.9	5,656,234	35.0
1935	170,216	10,444,228	61.4	5,876,097	34.5
1940	150,007	9,996,108	66.6	6,038,067	40.3
1945	129,295	10,039,657	77.6	5,135,416	39.7
1950	124,182	11,202,278	90.2	5,657,467	45.6

Source: Agricultural Census Reports, Bureau of the Census, United States Department of Commerce.

Note: Data are obtained through a cooperative agreement between the Louisiana Office of Agricultural Estimates, Bureau of Agricultural Economics, United States Department of Agriculture, and the Department of Agricultural Economics, Agricultural Experiment Station, Louisiana State University.

The number of farms in Louisiana as reported by Census periods increased from 115,969 in 1900 to 170,216 in 1935, the greatest number of record. The number of farms had declined to 124,182 by 1950 which was 27 per cent fewer farms than the number in 1935 and only 6.6 per cent more farms than the number in 1900 (Table 1). In 1950 there were 34,292, or 68.3 per cent, fewer "cropper" farmers, 14,886, or 25.5 per cent, fewer other kinds of tenant farms and 13,074, or 21.2 per cent, more owner and part-owner operated farms than in 1935 (Table 2). The number of operator owned and part-owned farms increased from 36.0 to 60.4 per cent of the total number of farms in the state from 1935 to 1950. The marked improvement in the farm tenure situation since 1935 contributed its part to the increased volume of agricultural production in Louisiana.

Since the acres in cropland changed in lesser proportion than the number of farms between 1935 and 1950, the average cropland acres per farm increased from 34.5 to 45.6. The average number of acres per farm of cropland harvested changed but little from census period to census period. Average acreages were: 26.3, 25.2, 23.4, 27.0, 27.0, and 25.4, respectively, for the census years 1925, 1930, 1935, 1940, 1945, and 1950.

The volume of production on Louisiana farms has been increasing for many years. However, increases in volume of production have not occurred each year over the preceding year. Increases or decreases from year to year often are due in part to variations in weather and other conditions over which farmers have little or no control. Increases in the volume of agricultural production have been due in part to increased mechanization, improvements in seed and animal breeding, the use of increasing volumes of fertilizer, and to improvements in farm management practices.

The volume of agricultural production in 1910-14 averaged 68 per cent of the 1935-39 average. The average volume of agricultural production in 1930-34 was 81 per cent of the 1935-39 average, and the average increased to 93 per cent in 1940-44 and was the same (93 per cent) in 1945-49. Louisiana farmers' volume of production of agricultural products was 37 per cent greater in 1945-49 than in 1909-13.

Agricultural production is accomplished through the utilization of the factors of production—land, labor, and capital. Increased volume may be obtained by increases in quantities utilized of any or all of the factors, or by increased efficiency in the use of one or more of the factors. The acreage of land in farms and acres of cropland in Louisiana have changed little since 1900, as shown in estimates by the Bureau of the Census (Table 1). Cropland harvested in Louisiana amounted to 3,924,267 acres in 1919 as compared with a harvested acreage of 3,148,331 in 1949. This represents a decline of 775,388 acres harvested, or a decline of 19.8 per cent. The composite index of volume of agricultural production averaged 68.2 in 1909-13 (1935-39 = 100) as compared with an average index of volume of production of 93.4 in 1945-49. Louisiana farmers produced 37.0 per cent greater volume of farm products from 1945 through 1949 than the average in 1909-13, and furthermore the production was on 19.8 per cent fewer acres of land.

According to reports of the Bureau of the Census the farm labor force in Louisiana, including farm operators, unpaid family workers, and hired workers, utilized in agricultural production numbered 334,439 in 1910 as compared with 190,283 in 1950. This represents a decline of 43 per cent, from 1910 to 1950, in the labor force engaged in agricultural production. This indicates that the 37.0 per cent greater volume of

Table 2. - Farm Tenure in Louisiana 1900-1950

		1900 Census	1910 Census	1920 Census	1925 Census	1930 Census	1935 Census	1940 Census	1945 Census	1950 Census
Number of farms		115,969	120,546	135,463	132,450	161,445	170,216	150,007	129,295	124,181
White operators	number	56,545	64,794	73,404	72,937	87,675	99,901	90,901	90,423	83,525
Non-white operators	number	58,038	54,802	62,059	59,513	73,770	70,315	59,584	49,131	40,656
Full owners	number	44,715	48,590	51,895	47,913	46,893	54,891	52,936	58,761	62,810
Part owners	number	2,634	4,399	5,359	4,473	6,266	6,429	7,376	6,433	11,584
Proportion owners --	per cent	40.8	44.0	42.3	39.6	32.9	36.0	40.2	50.9	60.4
Managers	number	1,034	950	828	503	735	519	528	560	588
All tenants[1]	number	67,234	66,607	77,381	79,561	107,551	108,377	89,167	63,541	49,199
Croppers	number			31,309	34,074	49,428	50,219	39,631	25,221	15,927
Share	number	38,312 1/	50,072 1/	30,499	2/	2/	2/	31,460	20,548	21,984
Cash	number	28,922	14,486	10,905	8,742	12,886	2/	11,201	9,474	5,789
Share-cash	number	2/	1,362	1,193	2/	2/	2/	1,469	3,568	710
Other and unspecified	number	2/	2,049	4,668	36,745	45,237	58,058	5,406	4,730	4,789

1/ Includes croppers.

2/ Not available.

Source: Agricultural Census Reports, Bureau of the Census, U. S. Department of Commerce.

agricultural production in 1945-49 than in 1909-13 was achieved not only on 19.8 per cent fewer acres of harvested cropland but also with 43 per cent less labor.

Of the three factors used in agricultural production more far-reaching changes occurred in the use of capital during the last 50 years. Louisiana farmers' cash outlay for hired labor increased from $21,418,399 in 1919 to $38,912,330 in 1949, an increase of $17,493,911, or 81 per cent. Farmers spent $12,232,235 for feed in 1919 as compared with $21,948,657 in 1949, an increase of 72 per cent in 30 years. Increased capital outlay was required in greater mechanization of farmers' operations, as illustrated in the increase from 1920 to 1950 of tractors from 2,812 to 36,059, of trucks on farms from 874 to 36,445, and of automobiles from 10,512 to 56,505. Heavy equipment is the rule rather than the exception in the sugar cane area at present. Harvesters have replaced binders largely in the rice producing area and mechanical cotton pickers are used in increasing numbers in the Delta Cotton areas of the state. Farmers' expenditures for fertilizer and insecticides increased tremendously during the last 25 years (Table 3).

Table 3. - Amount of fertilizer used by farmers, Louisiana, 1890-1951.

Season ending August 31	TONS	Season ending August 31	TONS	Season ending August 31	TONS
1890	11,120	1911	91,085	1932	52,501
1891	11,371	1912	85,475	1933	55,195
1892	7,945	1913	98,778	1934	80,945
1893	12,047	1914	90,588	1935	93,290
1894	8,496	1915	74,420	1936	111,504
1895	4,783	1916	75,151	1937	157,197
1896	10,051	1917	98,264	1938	148,688
1897	12,342	1918	118,429	1939	149,048
1898	14,404	1919	97,724	1940	168,292
1899	23,866	1920	95,863	1941	172,154
1900	31,813	1921	38,760	1942	168,536
1901	47,943	1922	66,470	1943	182,993
1902	53,874	1923	108,712	1944	204,300
1903	76,197	1924	129,288	1945	213,961
1904	95,964	1925	103,989	1946	245,741
1905	94,729	1926	116,049	1947	251,468
1906	84,626	1927	91,095	1948	232,659
1907	102,454	1928	136,324	1949	258,813
1908	84,124	1929	170,153	1950	274,676
1909	83,710	1930	185,145	1951	324,708
1910	88,396	1931	96,168	1952	-----

Source: Unpublished data in the Office of the Louisiana Department of Agriculture and Immigration.

Louisiana farmers used an average of 61,158 tons of fertilizer in the five-year period 1900-1904. They used an average of 87,819 tons in 1920-24, an increase of 43 per cent. This tonnage increased to an average of 268,505 in 1947-51, an increase of 206 per cent over the average used in 1920-24.

Improved seed, more timely and better cultural practices, and other improved practices made their contribution to increases in yield per acre and to increases in volume of production.

The widely separated locations of the different types of farms and the degree to which they were able to adopt and benefit from technological improvements enabled some areas to increase yields and production earlier and more rapidly than others.

Increasing productivity of farm workers probably is the best single measure of progress in efficiency in agriculture. Production per farm worker rose sharply during and following World War II. Increased yields of crops and livestock resulted in increasing production per man hour and per worker in agriculture.

Displacement of horses and mules by tractors, motor trucks, and automobiles occurred on many Louisiana farms from 1910 to 1952. The number of horses and mules on farms declined from 310,000 in 1910 to 209,000 in 1952. This change permitted greatly expanded production of food and fiber for human use, as thousands of acres of cropland were released from production of feed and pasture for horses and mules and utilized for producing food and fiber. The decrease in number of work stock on farms made it possible to increase other livestock on farms and thereby increase the output of milk, meat, and eggs.

Production costs continue to rise, particularly cash outlay. Farm wage rates are about four and one-half times the 1910-14 level and prices farmers pay for commodities used in agricultural production are about three times as high as the 1910-14 level. Cost of production in agriculture has been an ever increasing problem for Louisiana farmers since the beginning of World War II. Costs of production have not increased at the same rate on all types of farms. Generally, the greatest proportionate increases in costs of production were on dairy and cotton farms.

Mechanical power and labor-saving machines are gaining in importance in the cotton fields but the harvest job is still a time-consuming hand operation. Mechanical cotton pickers are being purchased by some of the larger operators; however, it is estimated that 95 per cent of the 1950 cotton crop in Louisiana was picked by hand labor.

The secular or long-time trend in volume of agricultural production was sharply upward from 1909 through 1951. The average annual increase in total volume of agricultural production was 0.92 index points during the period.

The total volume of agricultural production follows a definite cyclical pattern. Ten production cycles, from trough through peak to trough, were completed from 1909 through 1950 (Table 4). Volume of agricultural production cycles ranged from three to eight years in length. However, there was only one cycle of more than five years duration. The average length of the cycle was 4.1 years. The average length of the duration of business cycles in the United States from 1867 through 1938 was 4.01 years.[1] The average length of time of increase in the volume of Louisiana farm production in the ten completed cycles was 1.9 years as compared with an average of 2.18 years in the business cycle in the United States. The average length of decline per cycle for Louisiana's volume of agricultural production was 2.2 years and for the United State business cycle 1.8 years. Many characteristics of the cycles in the two series are similar or comparable (Table 4). With one exception (1918) the bottom of the volume of agricultural production cycle was higher than the bottom of the preceding cycle. There were 20 years in which volume of production was greater than in the preceding year and 19 years in which declines occurred. The arithmetic mean of the 20 increases over the previous year in volume of production was 13 per cent as compared with an average of 8.7 per cent, for the 17 declines.

Cattle and Calves

The number of cattle in Louisiana increased period by period from 1867 to 1952 (Table 5). The periods are well defined cycles from trough through peak to trough in numbers of cattle. There were seven completed cycles from 1870 through 1949 (Figure 1). The average duration of cycles was 11.4 years. The average number of years of increases in numbers of cattle on the up side of the cycle was 6.3 per cycle as compared with an average of four years on the declining side of the cycle. In each completed cycle in numbers of cattle in Louisiana the bottom or trough of the cycle was higher than the bottom of any preceding cycle and the peak or top of every cycle after 1870 was higher than the peak of any preceding cycle. The secular or long-time trend in cattle numbers is upward. The average annual increase in the number of cattle was 1.0 index point during the 85 years. The smallest number of cattle in Louisiana since 1867 was 400,000 in 1869 and again in 1870 and the greatest number was in 1945, when there were 1,561,000 cattle in the state.

Meat Animals and Animal Products

Detailed data on the volume of production of livestock and livestock products are not available prior to 1924. Since that time the increase in volume of production in livestock enterprises has been greater than in the volume of production of field crops.

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[1] Achinstein, Asher. *Introduction to Business Cycles.* New York: Thomas Y. Crowell Company, 1950. P. 162, Table 2.

Table 4. - Reference dates and duration of cycles, Louisiana and United States, 1909-50

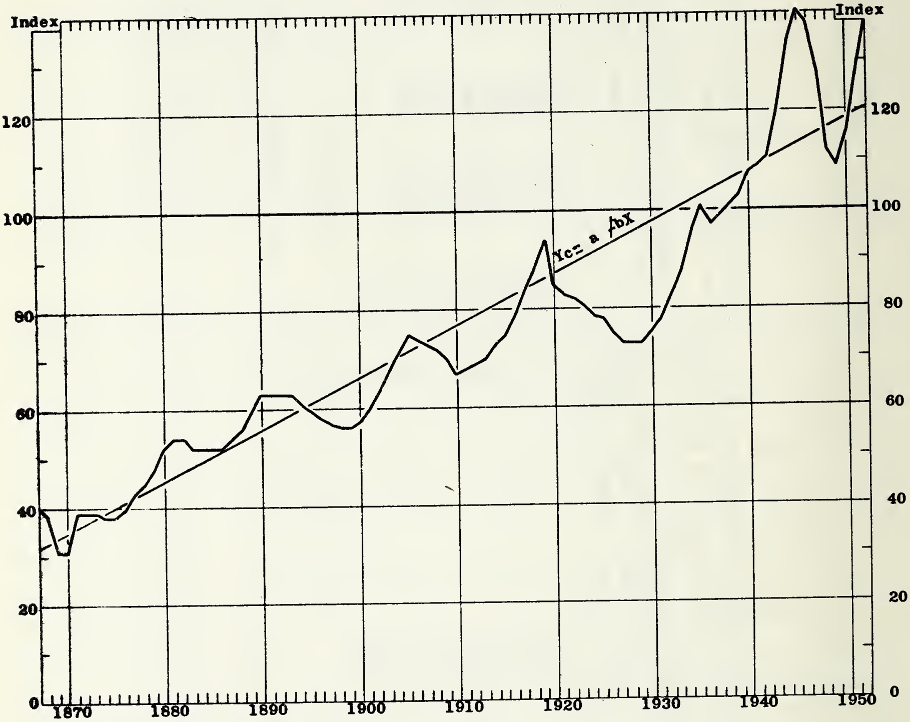
Louisiana agricultural production cycles [1/]							United States business cycles [2/]						
Cycle	Trough	Peak	Trough	Duration	Advance	Decline	Cycle	Trough	Peak	Trough	Duration	Advance	Decline
1	1909	1911	1912	3	2	1	1	1908	1910	1912	4	2	2
2	1912	1913	1915	3	1	2	2	1912	1913	1914	2	1	1
3	1915	1916	1919	4	2	2	3	1914	1918	1919	5	4	1
4	1919	1920	1923	4	1	3	4	1919	1920	1921	2	1	1
5	1923	1925	1927	4	2	2	5	1921	1923	1924	3	2	1
6	1927	1929	1930	3	2	1	6	1924	1926	1927	3	2	1
7	1930	1931	1933	3	1	2	7	1927	1929	1933	6	2	4
8	1933	1937	1941	8	4	4	8	1933	1937	1938	5	4	1
9	1941	1943	1946	5	2	3							
10	1946	1948	1950	4	2	2							
	Total			41	19	22					30	18	12
	Average			4.1	1.9	2.2					3.8	2.2	1.5

1/ Table 6, and Figure 2.

2/ Achinstein, Asher. Introduction to Business Cycles. New York: Thomas Y. Crowell Company, 1950. P. 162.

The index of volume of all agricultural production, the index of volume of production of livestock and livestock products, and the index of volume of production of all crops, averaged 80, 78, and 81, respectively, for the five-year period 1925-29 as compared with a composite index of 93, a livestock and livestock products index of 116, and an all-crops index of 85 as averages in 1945-49 (Table 6).

Figure 1. Index Numbers of the Numbers of Cattle in Louisiana, 1867-1952 (1935 - 39 = 100)



Source: Table 5, Pages 13-14.

Table 5. - All cattle: Number, value, and purchasing power, Louisiana, 1867-1952 (1935-39 = 100)

Year	Number on farms	Number per 100 of population	Index of number	Value per head	Index of Value	Index of wholesale prices	Index of purchasing power
	Thousands			Dollars			
1867	450	62.5	40	10.50	55.9	130.2	42.9
1868	430	59.5	39	7.30	38.8	121.3	32.0
1869	400	55.2	36	9.90	52.7	116.1	45.4
1870	400	55.1	36	14.80	78.7	107.6	73.1
1871	430	58.4	39	16.70	88.8	102.8	86.4
1872	430	56.6	39	15.30	81.4	104.9	77.6
1873	430	55.0	39	14.80	78.7	103.9	75.7
1874	420	52.3	38	12.30	65.4	100.5	65.1
1875	425	50.9	38	11.80	62.8	96.4	65.1
1876	445	52.0	40	12.50	66.5	89.4	74.4
1877	475	54.1	43	12.00	63.8	83.8	76.1
1878	500	55.6	45	12.80	68.1	76.6	88.9
1879	540	58.7	48	10.00	53.2	73.0	72.9
1880	575	61.1	52	11.50	61.2	80.8	75.7
1881	600	62.5	54	12.30	65.4	79.9	81.9
1882	600	61.4	54	13.20	70.2	82.1	85.5
1883	580	58.3	52	12.90	68.6	80.2	85.5
1884	575	56.8	52	14.00	74.5	75.1	99.2
1885	575	55.8	52	13.80	73.4	70.3	104.4
1886	580	55.3	52	13.40	71.3	69.5	102.4
1887	600	56.3	54	12.80	68.1	70.0	97.3
1888	630	58.1	56	12.30	65.4	71.3	91.7
1889	670	60.8	60	11.70	62.2	71.3	87.2
1890	700	62.5	63	11.20	59.6	69.8	85.4
1891	705	61.5	63	11.20	59.6	69.3	86.0
1892	706	60.2	63	11.60	61.7	64.8	95.2
1893	700	58.3	63	11.90	63.3	66.3	95.5
1894	685	55.9	61	10.80	57.4	59.5	96.5
1895	670	53.5	60	9.50	50.5	60.6	83.3
1896	650	50.8	58	9.70	51.6	57.7	89.4
1897	640	49.0	57	10.40	55.3	57.8	95.7
1898	625	46.9	56	11.50	61.2	60.2	101.7
1899	625	46.0	56	14.00	74.5	64.8	115.0
1900	640	46.2	57	15.60	83.0	69.6	119.3
1901	675	47.8	60	13.60	72.3	68.6	105.4
1902	715	49.7	64	13.90	73.9	73.1	101.1
1903	760	51.8	68	14.30	76.1	74.0	102.8
1904	800	53.5	72	13.60	72.3	74.1	97.6
1905	835	54.8	75	12.60	67.0	74.6	89.8
1906	825	53.2	74	14.00	74.5	76.7	97.1
1907	820	51.9	73	13.50	71.8	80.9	88.8
1908	800	49.8	72	13.80	73.4	78.1	94.0
1909	780	47.7	70	13.80	73.4	83.9	87.5
1910	748	44.9	67	14.70	78.2	87.4	89.5
1911	755	44.5	68	17.30	92.0	80.6	114.1
1912	765	44.8	69	17.20	91.5	85.8	106.6

Continued-

Table 5. - All cattle: Number, value. and purchasing power, Louisiana, 1867-1952
Continued
(1935-39 = 100)

Year	Number on farms	Number per 100 of population	Index of number	Value per head	Index of Value	Index of wholesale prices	Index of purchasing power
	Thousands			Dollars			
1913	780	45.2	70	17.40	92.6	86.6	106.9
1914	810	46.6	73	21.10	112.2	84.5	132.8
1915	840	47.9	75	22.20	118.1	86.3	136.8
1916	885	49.2	79	22.30	118.6	106.1	111.8
1917	935	52.1	84	25.60	136.2	145.9	93.4
1918	980	56.1	88	30.10	160.1	163.0	98.2
1919	1,045	59.5	94	33.40	177.7	172.0	103.3
1920	950	52.4	85	36.50	194.1	191.7	101.3
1921	931	50.4	83	28.00	148.9	121.2	122.9
1922	912	48.7	82	20.30	108.0	120.0	90.0
1923	902	47.4	81	18.90	100.5	124.9	80.5
1924	884	45.6	79	19.10	101.6	121.8	83.4
1925	871	44.2	78	17.80	94.7	128.5	73.7
1926	836	41.7	75	19.20	102.1	124.1	82.3
1927	819	40.2	73	20.70	110.1	118.4	93.0
1928	810	39.2	73	23.70	126.1	120.0	105.1
1929	819	39.3	73	31.90	169.7	118.3	143.4
1930	836	39.7	75	30.70	163.3	107.2	152.3
1931	869	40.6	78	22.70	120.7	90.6	133.2
1932	920	42.2	82	18.20	96.8	80.4	120.4
1933	986	44.6	88	13.10	69.7	81.8	85.2
1934	1,070	47.8	96	13.30	70.7	93.0	76.0
1935	1,125	49.6	101	14.20	75.5	99.3	76.0
1936	1,080	47.3	97	18.60	98.9	100.3	98.6
1937	1,102	48.2	99	19.40	103.2	107.1	96.4
1938	1,125	48.7	101	20.10	106.9	97.6	109.5
1939	1,148	48.9	103	21.70	115.4	95.7	120.6
1940	1,204	50.9	108	23.80	126.6	97.6	129.7
1941	1,216	50.8	109	24.50	130.3	108.4	120.2
1942	1,240	52.4	111	32.20	171.3	122.6	139.7
1943	1,351	58.4	121	39.90	212.2	128.0	165.8
1944	1,500	65.8	134	42.50	226.1	129.1	175.1
1945	1,561	68.1	140	41.70	221.8	131.3	168.9
1946	1,545	62.4	138	45.70	243.1	150.3	161.7
1947	1,452	57.3	130	55.40	294.7	188.8	156.1
1948	1,249	48.4	112	68.50	364.4	204.9	177.8
1949	1,222	46.5	109	84.30	448.4	194.1	231.0
1950	1,285	47.9	115	86.30	459.	188.1	244.0
1951	1,426	52.4	128	117.00	622.	223.6	278.2
1952	1,540	55.8	138	127.00	676.	220.7	306.3

Sources: See following page.

Sources used in Table 5:

Data on numbers and value: Compiled from Bureau of Agricultural Economics releases as follows:

1867-1935, from Livestock on Farms, Jan. 1, 1867-1935, released January 1938.
1936-1939, from Agricultural Statistics, 1942.
1940-1945, from Livestock and Poultry on Farms, Jan. 1, Revised Estimates, 1940-45, released February 1947.
1946-1952, from Livestock on Farms, Jan. 1, released annually.

Data on population:

1867-1874, estimates were furnished by the Dept. of Rural Sociology, L. S. U.
1875-1940, estimates were furnished by Leon E. Truesdell, Chief, Population Division, Bureau of the Census. December 13, 1943.
1941-1948, from Current Population Reports, "Population Estimates," Series P-25, No. 12, August 9, 1948; and Series P-25, No. 26, Aug. 5, 1949.
1949-1952, Estimated.

Data on index of wholesale prices:

1867-1912, from Bureau of Labor Statistics Bulletin No. 543, September 1931.
1913-1947, from mimeographed release No. 14235, Bureau of Labor Statistics, 1948.
1948-1952, from Federal Reserve Bulletin, released monthly by the Board of Governors of the Federal Reserve System.

These data are published on a 1926=100 base and converted to 1935-39 base by multiplying by the conversion factor - 1.24131082.

Source: Table 5, Page ??

Figure 1. Index Numbers of the Numbers of Cattle in Louisiana, 1867-1952
(1935 – 39 = 100)

The volume of production of meat animals expanded materially from 1924 to 1950. In the cyclical behavior in the volume of production of meat animals from 1924 through 1950 the trough of each cycle was higher than the bottom of any preceding cycle until the trough of 1948. The low point in 1948 was lower than the low point in the preceding cycle (1945). The secular trend in volume of production of meat animals was upward at an average annual rate of 2.8 index points. Increases in volume of production began in 1930, increases from the preceding year occurring 15 times from 1924 to 1950 as compared with declines from the preceding year's volume in only five years.

Beef cattle and veal calf production increased materially during the period studied. Louisiana ranked twenty-fifth in 1925, thirty-first in 1930, thirtieth in 1935 and 1940, thirty-first in 1945, and twenty-ninth in 1950 among the states in volume of cattle and calves produced (Table 8). Beef cattle and veal calves' rank in economic importance among agricultural products in Louisiana increased from fifth in 1925 to third in 1940, and then dropped to fourth in 1945 and again increased in importance to third in 1950 (Table 9). The average annual index of volume of beef cattle and veal calf production during the 1925-29 period

Table 6. - Index numbers of quantities of agricultural commodities produced, Louisiana, 1909-51
(1935-39 = 100)

Year	COMPOSITE OR TOTAL FARM PRODUCTION	MEAT ANIMALS AND ANIMAL PRODUCTS				
		Total livestock	Meat animals	Dairy products	Wool	Poultry and eggs
1909	60				64	
1910	66				65	
1911	72				76	
1912	61				84	
1913	72				73	
1914	68				86	
1915	62				81	
1916	78				85	
1917	84				87	
1918	82				91	
1919	58				83	
1920	72				84	
1921	68				77	
1922	68				77	
1923	60				78	
1924	63	72	64	72	83	91
1925	84	73	65	72	85	92
1926	79	77	65	77	83	104
1927	72	81	70	82	88	103
1928	80	78	60	82	92	106
1929	86	81	62	88	86	108
1930	79	81	63	87	98	107
1931	93	85	71	90	101	101
1932	82	88	80	93	101	94
1933	76	92	88	95	100	94
1934	77	93	91	97	98	89
1935	87	92	91	94	103	92
1936	97	95	95	96	96	95
1937	113	96	94	97	97	96
1938	101	106	109	105	99	103
1939	102	110	111	108	104	114
1940	81	101	100	102	106	103
1941	81	105	99	105	111	118
1942	98	111	103	108	109	130
1943	105	122	119	112	95	150
1944	98	122	121	113	84	143
1945	96	121	117	113	85	145
1946	84	115	120	108	79	120
1947	87	113	118	108	68	115
1948	101	112	115	106	56	119
1949	99	120	125	109	43	131
1950	91	118	125	110	38	119
1951	96	117	112	119	38	125

Continued

Table 6. - Index numbers of quantities of agricultural commodities produced, Louisiana, 1909-51--Continued
(1935-39 = 100)

	CROPS								
Year	All crops	Field crops	Cotton	Sugar cane	Food grains	Feed grains and hay	Commercial truck crops	Fruits	Pecans
1909	60	60	33	82	62	97		83	
1910	66	66	32	100	66	113		134	
1911	72	72	50	115	58	95		54	
1912	61	60	49	61	55	92		188	
1913	72	72	58	93	55	100		123	
1914	68	68	59	73	57	94		93	
1915	62	62	45	56	64	105		111	
1916	78	78	58	91	99	100		125	
1917	84	84	84	91	79	88		104	
1918	82	84	77	104	89	80	51	35	
1919	58	59	39	47	94	86	40	35	56
1920	72	74	51	62	124	99	46	41	8
1921	68	69	37	92	91	102	57	58	64
1922	68	68	45	86	95	85	50	69	7
1923	60	61	48	63	78	74	55	61	48
1924	59	59	65	50	75	53	60	61	20
1925	88	90	119	65	72	73	97	40	64
1926	80	79	109	26	80	67	102	84	69
1927	69	69	72	28	99	72	113	58	26
1928	81	79	92	46	93	74	109	109	64
1929	88	87	107	61	92	74	118	100	31
1930	78	77	94	56	94	53	85	82	93
1931	95	93	119	48	79	89	95	150	96
1932	80	78	81	57	82	85	76	122	73
1933	70	68	63	56	80	76	71	105	125
1934	72	70	64	66	84	67	100	107	50
1935	84	85	73	83	86	102	94	70	103
1936	98	98	100	97	104	87	93	108	86
1937	119	120	143	105	102	104	103	116	137
1938	99	99	87	112	102	109	108	92	84
1939	99	98	96	104	106	98	102	116	89
1940	74	73	59	63	94	100	94	91	112
1941	72	70	41	83	101	91	92	103	67
1942	93	91	77	93	115	96	103	128	79
1943	99	101	95	107	107	92	85	55	141
1944	89	90	80	97	105	81	97	56	174
1945	87	87	50	119	113	97	113	74	107
1946	73	71	32	101	111	75	106	98	108
1947	78	78	65	85	108	70	84	78	55
1948	97	97	97	95	122	80	78	78	228
1949	92	93	84	91	120	87	75	60	188
1950	82	83	55	99	114	90	78	65	100
1951	88	90	99	73	122	72	57	51	149

Continued

Table 6. - Index numbers of quantities of agricultural commodities produced, Louisiana, 1909-51--Continued
(1935-39 = 100)

Year	MEAT ANIMALS AND ANIMAL PRODUCTS						
	Meat Animals			Dairy Products			
	Beef cattle and calves	Hogs	Sheep and lambs	Milk (total)	Butter	Butterfat	Wool
1909							64
1910							65
1911							76
1912							84
1913							73
1914							86
1915							81
1916							85
1917							87
1918							91
1919							83
1920							84
1921							77
1922							77
1923							78
1924	60	67	63	72	66	71	83
1925	58	71	76	72	69	71	85
1926	54	74	72	77	74	78	83
1927	71	68	82	82	86	82	88
1928	59	60	83	82	84	82	92
1929	62	61	89	88	89	90	86
1930	69	56	85	87	91	86	98
1931	71	71	82	90	97	90	101
1932	76	84	99	93	104	93	101
1933	81	93	138	95	103	97	100
1934	81	101	103	97	101	97	98
1935	96	86	89	94	101	93	103
1936	95	95	92	96	100	97	96
1937	98	91	101	97	100	97	97
1938	106	112	105	105	101	104	99
1939	106	116	113	108	98	108	104
1940	103	96	109	102	84	104	106
1941	107	91	108	105	81	108	111
1942	109	99	37	108	72	112	109
1943	116	122	40	112	71	116	95
1944	121	123	65	113	75	116	84
1945	124	112	54	113	88	116	85
1946	132	110	44	108	84	112	79
1947	128	111	38	108	80	112	68
1948	121	111	46	106	77	108	56
1949	137	115	40	109	78	112	43
1950	134	91	34	117	71	119	38
1951	148	80	34	119	66	119	38

Continued

Table 6. - Index numbers of quantities of agricultural commodities produced, Louisiana, 1909-51--Continued
(1935-39 = 100)

Year	MEAT ANIMALS (continued)			CROPS					
	Poultry and eggs			Field Crops					
				Cotton		Sugar cane		Food Grains	
	Chickens	Turkeys	Eggs	Lint	Seed	Sugar	Syrup	Rice	Cowpeas
1909				33	34	86	58	62	
1910				32	33	102	91	66	
1911				50	52	117	104	58	
1912				49	51	52	118	55	
1913				58	60	89	116	55	
1914				58	61	69	97	57	
1915				44	46	48	102	64	
1916				58	60	87	116	99	
1917				83	87	82	142	79	
1918				77	80	87	210	89	
1919				39	40	45	56	94	
1920				50	53	62	65	124	
1921				36	38	93	89	91	
1922				45	46	85	91	95	
1923				48	50	58	94	79	
1924	84		97	64	67	35	141	74	107
1925	88		95	118	124	61	92	70	140
1926	100		107	108	113	20	63	80	82
1927	100		107	71	74	21	67	98	134
1928	95		116	90	100	39	94	93	98
1929	108	42	111	105	115	58	81	93	67
1930	112	58	104	93	101	51	87	95	52
1931	102	73	101	117	127	45	64	79	87
1932	97	98	90	80	89	58	51	81	109
1933	99	93	89	62	68	53	77	80	96
1934	95	91	83	63	69	62	88	83	114
1935	96	94	87	72	77	82	90	86	119
1936	102	107	89	99	107	97	96	104	94
1937	91	113	100	144	139	105	103	102	92
1938	98	86	108	88	85	115	93	103	88
1939	112	99	115	97	93	101	118	105	106
1940	102	96	105	59	58	60	80	93	127
1941	126	100	112	41	41	83	87	101	116
1942	132	91	129	77	74	95	81	116	108
1943	160	87	144	96	91	106	112	107	108
1944	133	76	153	81	76	98	94	105	81
1945	151	80	142	50	50	104	211	114	65
1946	119	84	121	32	31	90	166	112	56
1947	120	91	112	66	61	80	119	109	58
1948	124	84	116	98	92	105	31	123	65
1949	142	110	123	85	81	99	39	121	74
1950	111	150	140	55	52	106	56	115	44
1951	106	191	140	100	94	80	28	124	34

Continued

Table 6. - Index numbers of quantities of agricultural commodities produced, Louisiana, 1909-51--Continued
(1935-39 = 100)

Year	CROPS (continued)								
	Field Crops (continued)								
	Feed grains and hay			Soy-beans	Pea-nuts	Irish potatoes	Sweet potatoes	Tobacco	Tung nuts
	Corn	Oats	Hay						
1909	105	33	68		71	50	54		
1910	123	47	74		66	50	55		
1911	103	37	67		85	56	59		
1912	101	37	59		66	44	56		
1913	110	46	63		68	47	61		
1914	101	59	69		88	47	58		
1915	114	81	70		109	42	62		
1916	107	67	74		113	52	64		
1917	94	64	69		137	61	62		
1918	84	71	65		103	108	57		
1919	89	65	75		88	41	69	181	
1920	106	52	72		99	47	82	198	
1921	112	40	70		104	56	74	218	
1922	89	36	76		103	54	69	248	
1923	72	31	89		85	57	55	206	
1924	55	21	49	35	50	59	29	167	
1925	79	19	52	67	65	64	53	187	
1926	70	22	59	85	71	73	65	20	
1927	75	12	73	105	116	74	87	22	
1928	75	25	79	71	74	96	61	42	
1929	76	25	73	122	108	63	63	63	
1930	53	22	62	93	78	79	52	139	
1931	88	58	96	73	135	139	77	128	
1932	86	26	91	61	132	79	93	89	
1933	75	23	92	47	169	80	84	67	
1934	62	50	95	49	116	98	98	18	
1935	105	83	92	62	101	98	116	22	
1936	84	83	98	144	98	103	99	24	
1937	105	111	99	80	94	106	94	104	
1938	113	99	95	93	109	107	100	156	
1939	93	124	117	120	97	87	92	193	2
1940	94	164	117	112	93	88	63	72	13
1941	81	164	125	102	56	102	97	30	20
1942	89	187	110	499	183	98	101	36	44
1943	82	239	110	211	160	137	126	78	36
1944	66	285	113	153	32	130	125	109	84
1945	85	237	129	179	45	99	155	100	119
1946	61	170	123	195	26	88	137	78	168
1947	56	216	109	167	35	64	100	130	172
1948	69	231	105	272	24	55	100	124	155
1949	74	189	127	208	25	48	110	104	279
1950	71	67	112	370	24	34	139	78	68
1951	66	78	98	321	23	29	81	138	24

Continued

Table 6. - Index numbers of quantities of agricultural commodities produced, Louisiana, 1909-51--Continued
(1935-39 = 100)

Year	CROPS (continued)								
	Commercial Truck Crops								
	Snapbeans		Cabbage	Water-melons	Beets	Cucumbers		Toma-toes	Onions
	Spring	Fall				Spring	Fall		
1909									
1910									
1911									
1912									
1913									
1914									
1915									
1916									
1917									
1918	24		44						197
1919	23		49						103
1920	15		82						114
1921	28		79						139
1922	20	8	78						220
1923	19	22	86			47			72
1924	50	26	49			100			138
1925	65	60	118			78			185
1926	54	82	106			124		61	235
1927	60	75	121		91	122		72	209
1928	72	90	124		234	169	86	56	199
1929	113	115	114		215	131	80	46	191
1930	98	58	54		151	173	74	57	51
1931	108	65	139		130	107	88	60	66
1932	78	55	100		122	100	94	67	64
1933	52	71	83		110	76	91	93	23
1934	82	104	204	54	150	80	62	104	89
1935	106	103	65	70	136	120	79	91	65
1936	100	105	99	99	95	93	84	100	79
1937	90	85	109	131	110	98	64	93	123
1938	116	107	113	104	78	89	100	113	113
1939	90	100	114	97	81	100	170	102	119
1940	53	135	114	98	66	98	89	125	77
1941	76	46	151	76	62	129	80	106	113
1942	92	51	192	65	40	127	79	95	139
1943	77	54	128	63	39	96	130	76	108
1944	80	63	255	87	32	222	156	62	120
1945	96	98	265	74	25	180	123	85	147
1946	68	100	273	73	28	222	178	62	127
1947	50	46	282	67	24	107	67	51	83
1948	59	62	157	49	18	167	72	57	75
1949	55	65	175	50	14	116	100	60	87
1950	58	65	204	44	15	133	123	46	76
1951	53	48	41	36	6	127	78	40	54

Continued

Table 6. - Index numbers of quantities of agricultural commodities produced, Louisiana, 1909-51--Continued
(1935-39 = 100)

	CROPS (continued)							
	Commercial Truck Crops (continued)							
Year	Garlic	Shallots		Egg-plant	Green pepper	Carrots	Spinach	Truck crops (processing)
		Spring	Winter					
1909								
1910								
1911								
1912								
1913								
1914								
1915								
1916								
1917								
1918								
1919								
1920								
1921								
1922								
1923						123		
1924					59	112		
1925				89	108	215	164	
1926				82	119	242	139	
1927				82	114	375	149	
1928				127	117	160	184	58
1929				118	103	146	164	111
1930				104	68	108	82	172
1931				85	96	87	86	72
1932	78			93	46	82	84	51
1933	67			86	87	71	103	47
1934	78			96	60	94	116	42
1935	100			119	111	88	84	86
1936	78			65	77	85	92	59
1937	89	122	124	81	95	98	90	162
1938	122	90	77	132	140	107	113	125
1939	111	98	115	104	78	121	121	69
1940	111	96	107	99	64	90	96	141
1941	122	94	76	91	103	94	98	149
1942	189	110	123	85	65	84	82	215
1943	167	69	84	100	96	70	61	166
1944	144	59	57	82	111	59	57	124
1945	133	81	125	71	111	62	56	160
1946	122	77	148	64	79	55	52	110
1947	133	70	80	60	89	49	43	104
1948	111	67	106	61	140	45	40	51
1949	100	34	96	53	136	43	38	50
1950	100	74	83	53	98	37	31	105
1951	100	88	89	53	115	27	15	55

Continued

Table 6. - Index numbers of quantities of agricultural commodities produced, Louisiana, 1909-51--Continued
(1935-39 = 100)

Year	CROPS (continued)					
	Fruits				Pecans	
	Straw-berries	Oranges	Peaches	Pears	Im-proved	Wild
1909			100	25		
1910			168	21		
1911			65	16		
1912			234	36		
1913			150	32		
1914			110	36		
1915			132	38		
1916			152	36		
1917			125	34		
1918	26		143	40		
1919	29	13	131	40	33	72
1920	39	15	92	33	4	10
1921	60	18	81	32	41	79
1922	75	21	55	42	4	8
1923	66	27	40	29	32	60
1924	64	27	70	41	14	24
1925	37	36	82	47	45	76
1926	89	53	73	47	49	82
1927	60	71	30	36	20	31
1928	115	78	77	50	47	75
1929	107	67	67	48	24	36
1930	83	102	55	55	71	108
1931	158	87	135	87	80	108
1932	132	99	42	63	60	81
1933	110	87	82	47	103	139
1934	107	104	109	110	43	54
1935	66	87	96	77	86	116
1936	107	110	119	133	76	92
1937	124	85	80	51	147	131
1938	86	137	93	142	95	77
1939	118	102	112	99	95	85
1940	87	90	123	170	136	96
1941	105	68	115	117	62	71
1942	130	121	110	164	84	76
1943	51	85	60	53	117	158
1944	42	128	102	168	166	180
1945	65	117	110	156	82	124
1946	92	146	101	161	100	114
1947	72	107	93	142	62	51
1948	70	107	113	164	208	241
1949	49	128	91	136	98	250
1950	58	107	65	125	49	135
1951	51	18	79	85	102	180

Source: Computed from releases by the Bureau of Agricultural Economics, U. S. Department of Agriculture.

was 61 (1935-39 = 100) as compared with an average index of 132 during 1946-50. The long-time rate of increase in volume of production averaged approximately 3.4 index points per year.

The volume of production of hogs expanded materially in Louisiana from 1924 to 1950. Louisiana ranked twenty-fifth among the states in hog production in 1925, twenty-seventh in 1930, twenty-third in 1935, twenty-fifth in 1940 and 1945, and twenty-sixth in 1950 (Table 9). Cash income from farm marketings of hogs was sixth among Louisiana's farm products in 1925, ninth in 1930, sixth in 1935, and fifth in 1940, 1945, and 1950 (Table 8). Louisiana farmers are increasing the volume of pork production at the average annual rate of 2.4 index points. From 1924 to 1950, six well defined volume of pork production cycles were completed in Louisiana. The average duration of volume of production cycles, from trough through peak to trough, was 3.7 years. The average number of years of increase in volume per cycle was 2.2 as compared with an average decrease in volume of 1.5 years. The lowest volume of production of hogs was 56 per cent of the 1935-39 average in 1930 and the highest volume was 123 per cent of the 1935-39 average in 1944 (Table 6).

Indications are that sheep and lamb production for meat and wool is a vanishing enterprise in Louisiana. Increasing numbers of sugar cane planters are adopting the practice of substituting sheep for hand labor in controlling grass and weed growth in sugar cane. In spite of this new area for sheep raising, sheep and lamb production declined from the twentieth most important, as a revenue producer, among Louisiana crops in 1935 to the thirty-ninth in 1945 (Table 7). Sheep and lamb production advanced sharply from 63 per cent of the 1935-39 average volume in 1924 to 138 per cent in 1933. There was gradual decline from 1933 to 1941 and then a sharp drop from an index of volume of production of 108 in 1941 to 37 in 1942. The range in index of volume of production since 1941 was from 37 to 65. The volume of sheep and lamb production in the last five years, 1946-50, amounted to only 42 per cent of the volume in 1935-39. The average rate of decrease in volume of sheep and lamb production from 1924 through 1950 was 1.9 index points per year.

The volume of production in Louisiana's dairy enterprise expanded noticeably from 1924 through 1950 (Table 6). Volume of milk production increased from the preceding year's production in 16 of the 25 years, was unchanged four times, and declined in five instances (Table 6). Louisiana farmers' cash income from milk sold at wholesale varied from tenth place among agricultural products sold in 1925 to eighth in rank in 1930, ninth in 1935, sixth in 1940, seventh in 1945, and sixth in 1950 (Table 7). The secular trend in milk production was upward at an average annual rate of 1.5 index points from 1925 through 1950. There were wider fluctuations in the volume of butter produced than in all milk (Table 6). The secular trend in butter production was down-

Table 7. - Rank in cash income from farm marketings of agricultural products, Louisiana, 1910-1950

Commodity	1910	1915	1920	1925	1930	1935	1940	1945	1950
LIVESTOCK AND PRODUCTS									
Cattle and calves	--	--	--	5	4	4	3	4	3
Hogs	--	--	--	6	9	6	5	5	5
Sheep and lambs	--	--	--	26	25	20	27	39	38
Milk, wholesale	--	--	--	10	8	9	6	7	6
Milk, retail	--	--	--	7	7	7	8	13	12
Butter	--	--	--	25	21	22	29	34	30
Butterfat	--	--	--	31	18	17	19	33	43
Wool	11	12	15	24	26	24	25	32	33
Chickens	--	--	--	13	10	18	13	12	9
Turkeys	--	--	--	--	32	31	32	37	26
Eggs	--	--	--	9	11	12	10	10	11
ALL CROPS									
Cotton lint	2	1	1	1	1	1	1	1	1
Cottonseed	6	4	5	4	5	5	9	11	7
Sugar cane for sugar	1	2	3	3	3	2	4	3	4
Sugar cane syrup	5	5	4	12	12	10	11	8	14
Rice	3	3	2	2	2	3	2	2	2
Cowpeas for peas	--	--	--	17	39	30	37	41	32
Corn	4	6	9	15	16	13	15	16	13
Oats	12	11	19	37	40	35	35	22	16
Hay, all	9	9	10	30	22	19	21	23	21
Soybeans for beans	--	--	--	22	19	37	38	26	18
Peanuts	13	13	17	36	38	41	43	44	42
Irish potatoes	8	8	8	14	13	14	14	14	17
Sweet potatoes	7	7	7	8	14	11	12	6	10
Tobacco, perique	--	--	16	27	33	42	45	40	40
Tung nuts	--	--	--	--	--	--	40	18	22
Snap beans	--	--	14	16	15	15	17	15	19
Cabbage	--	--	11	20	20	21	20	20	25
Watermelons	--	--	--	--	--	32	24	28	29
Beets	--	--	--	--	24	28	41	45	45
Cucumbers	--	--	--	34	28	29	34	27	28
Tomatoes	--	--	--	23	29	25	23	25	24
Onions	--	--	12	19	31	33	28	30	34
Garlic	--	--	--	--	--	40	44	38	39
Shallots	--	--	--	--	--	--	18	19	20
Eggplant	--	--	--	32	35	34	39	42	41
Green peppers	--	--	--	21	30	27	31	24	27
Carrots	--	--	--	18	27	26	30	35	37
Spinach	--	--	--	33	37	39	42	43	44
Truck crops, processing	--	--	--	--	23	38	33	31	36
Strawberries	--	--	6	11	6	8	7	9	8
Oranges	--	--	18	28	17	16	22	21	23
Peaches	10	10	13	29	34	23	26	29	31
Pears	--	--	20	35	36	36	36	35	35
Pecans	--	--	--	--	--	--	16	17	15

Source: Compiled from releases by the Bureau of Agricultural Economics, U. S. Department of Agriculture.

ward at an average annual rate of 0.4 index point. Total butterfat production varied about the same as that of all milk until about 1939, after which volume of butterfat production increased more rapidly than the volume of all milk, thereby indicating improved breeding and improvements in dairy management practices. The secular trend for production of butterfat was upward at an average annual rate of 1.7 per cent from 1924 through 1949 (Table 6). Cash income from marketings of butterfat ranked this product as forty-third among agricultural products in economic importance in Louisiana in 1950.

The index of volume of wool production averaged 59 (1935-39 = 100) in 1909 through 1913. The volume of production rose slowly but regularly until the index of volume reached 101 in 1931. From 1931 through 1942 the range of volume produced ranged from a low 96 to a high of 111 per cent of the average in 1935-39. The average production in this twelve-year period was 102 per cent of the volume average in the base years. The average of the indexes of volume of production of wool in the most recent five years, 1947-51, is 49. The smallest volume of record is shown in 1950 and 1951 when volume of production of wool amounted to only 38 per cent of the average produced from 1935 through 1939. There has been little if any change over the years in the weight of the wool per fleece; rather the decline in the volume of wool production is due to decreasing number of sheep in the state. There were 255,000 sheep in Louisiana in 1942 as compared with 83,000 in 1950. Apparently sheep and wool production are fighting a losing battle in competition with other agricultural products for the factors of production—land, labor, and capital.

The poultry enterprise expanded rapidly in Louisiana from 1924 through 1950 (Table 6). A well defined cyclical pattern was followed in volume of production of poultry and eggs during the period. There were three cycles completed from trough through peak to trough from 1924 to 1947. The first cycle occurred from 1924 through 1934, the second from 1934 to 1940, and the third cycle from 1940 through 1947. The secular trend in volume of production of poultry and eggs was upward at the average rate of 1.6 index points per year. The volume of chicken production fluctuated widely during the period. Seven cycles, from trough through peak to trough, were completed between 1924 and 1946. The greatest volume of production occurred in 1943 when 160 per cent of the average in 1935-39 was produced. The long-time average increase in volume of production of chickens was 1.9 index points per year. The index of volume of chicken production in the state averaged 93 from 1924 through 1928 as compared with an average index of 126 from 1946 through 1950.

The number of turkeys produced in Louisiana increased irregularly from 28,000 in 1929 to 68,000 in 1937; since then there has been a tendency to produce slightly fewer turkeys. The average of the index of volume of production by weight from 1929 through 1933 was 73 (1935-39 = 100) as compared with an average index of volume of 98 in 1946-50. The secular trend in volume of turkey production is upward at the average annual rate of 0.9 index point.

Egg production fluctuated widely during the 27 years 1924-50. Volume of production followed the cyclical pattern. There were three complete cycles from trough through peak to trough. The first cycle included eleven years—three years of increasing volume and seven years decline; the second cycle extended through seven years—five years advance and one year decline; and the third cycle was completed in seven years—four years of increasing volume and three years decline. The long-time average rate of increase in volume of egg production was 1.4 index points per year. The average index of volume of egg production in the five-year period 1924-28 was 104 as compared with an average index of 119 in 1946-50. The index of volume of production of eggs has not been below 100 any year since 1936.

Field Crops

Cotton ranked first among all agricultural enterprises in Louisiana as a revenue producer in 40 of the 43 years from 1909 through 1951. Louisiana's rank in cotton production ranged from sixth to eleventh among the states during this period.

The volume of cotton produced in Louisiana varies widely from year to year and from cycle to cycle. There were ten cotton production cycles, from trough through peak to trough, completed in Louisiana from 1910 through 1950. The average length of the volume of production cycle was four years. The average duration of increases in production per cycle was two years as compared with an average decline of 1.9 years. While extreme variations in volume of cotton production characterized the behavior pattern, the long-time trend from 1909 through 1949 was upward at an average annual rate of approximately 0.8 index point. In general, the volume of cotton production increased from 1909 through 1937. Since 1937 there has been a noticeable decline in cotton production. Average volume of production from 1909 to 1913 was 44 per cent of the average in 1935-39. By 1925-29 the average volume was 100 per cent of the average in 1935-39. The average volume of production averaged 66.6 per cent of the 1935-39 average in 1946-50. However, the index of volume of production of cotton increased to 99 in 1951, the greatest volume since 1937. The volume of cottonseed production varies directly, but not necessarily at an identical rate, with the volume of cotton lint.

The volume of sugar cane (for sugar) produced in Louisiana fluctuated widely from 1909 through 1950. The sugar cane (for sugar) crop ranged in rank, as a revenue producer among Louisiana crops, from first to seventh from 1909 through 1950. Sugar cane ranked among the first three crops in economic importance until 1946, since which time the beef cattle and veal calf enterprise has displaced it as third in cash income from farm marketings (Table 7). Louisiana always has ranked first among the states in sugar cane (for sugar) production (Table 8). As a matter of fact the major part of sugar cane (for sugar) produced in the United States is produced in Louisiana. Thirteen cycles in volume of production of sugar cane, from trough through peak to trough, were completed from 1909 through 1951 if we may assume that the extremely low volume of production in 1951 is the bottom of the trough in the most recent cycle. The average duration of sugar cane production cycle was 3.3 years, with an average of 1.8 years per cycle increase in volume produced and an average of 1.5 years decline in volume. In general, volume of sugar cane production declined from 1909 to 1926, since which time there has been a tendency to increase the volume of production. The average of the index of volume of production was 54 in 1930-34 as compared with an average index of 94 in 1947-51. The over-all or long-time trend from 1909 through 1951 in the volume of production of sugar cane was upward at an average annual rate of 0.6 index point.

The volume of production of sugar cane syrup fluctuated even more widely than the volume of production of sugar cane for sugar (Table 6). Production declined from 211 per cent of the 1935-39 average in 1945 to 28 per cent of that average in 1951. The volume increased from an index of 31 in 1948 to 39 in 1949 and further to 56 in 1950 and then declined to 28 per cent of the base average in 1951. The volume in 1951 was the lowest of record. The long-time trend in volume of syrup production was downward at an average annual rate of 0.14 index point. Syrup production declined materially in economic importance among agricultural products in Louisiana from 1909 to 1951 (Table 5). In 1910 sugar cane syrup ranked fifth as a revenue producer among crops in Louisiana as compared with fourteenth in 1950; however, Louisiana consistently ranks first among the states as a producer of sugar cane syrup.

The volume of rice produced in Louisiana fluctuated less widely than volumes of other major crops from 1909 through 1951. Cyclical behavior in volume of production with, in general, succeeding cyclical peak and trough points being higher than those preceding are shown by the production data. Rice has not ranked less than third among agricultural enterprises, as a cash income crop, in Louisiana since 1909 (Table 7). Louisiana consistently produced more rice than any other state until 1950, when Texas's production exceeded Louisiana's. The secular trend in volume of rice production was upward at an average annual rate of 1.2 index points from 1909 through 1949. The increase in volume of rice production has been rather regular and constant. The index of volume exceeded 100 (1935-39 = 100) only one year prior to 1936. Since 1936 the index of volume has been less than 100 in one

Table 8. - Louisiana's rank among the states in volume of production of selected agricultural commodities, 1910-1950

Commodity		1910	1915	1920	1925	1930	1935	1940	1945	1950
LIVESTOCK AND PRODUCTS										
Cattle and calves		--	--	--	35	31	30	30	31	29
Hogs		--	--	--	25	27	23	25	25	26
Sheep and lambs		--	--	--	33	33	33	32	35	35
Milk, total		--	--	--	39	39	38	37	36	36
Butter		--	--	--	32	27	27	23	18	14
Butterfat		--	--	--	39	37	37	34	33	33
Wool		37	32	33	31	32	32	32	32	32
Chickens		--	--	--	31	28	31	29	28	28
Turkeys		--	--	--	--	42	44	45	47	45
Eggs		--	--	--	33	34	34	35	37	39
ALL CROPS										
Cotton lint		9	9	9	8	9	6	11	9	8
Cottonseed		--	--	--	--	9	8	10	10	8
Sugar cane for sugar		1	1	1	1	1	1	1	1	1
Sugar cane syrup		1	1	2	1	1	1	1	1	1
Rice		1	1	1	1	1	1	1	1	2
Cowpeas for peas		--	--	--	6	11	9	9	8	8
Corn		25	24	25	26	25	23	25	26	26
Oats		39	39	40	43	40	35	29	32	35
Hay, all		43	45	45	43	45	44	42	44	43
Soybeans for beans		--	--	--	9	7	13	18	19	18
Peanuts, picked and threshed		11	10	12	12	12	12	12	13	13
Irish potatoes,	all	37	39	39	35	38	34	34	31	36
	early*	6	7	8	7	9	8	9	7	9
Sweet potatoes		7	7	4	5	6	2	3	1	1
Tobacco, perique		--	--	1	1	1	1	1	1	1
Tung nuts		--	--	--	--	--	--	3	2	2
Snap beans*	mid-spring	--	--	4	2	2	2	2	3	3
	early fall	--	--	--	3	3	3	4	4	5
Cabbage*	early spring	--	--	3	2	4	3	2	3	3
Watermelons*	early summer	--	--	--	--	--	11	11	11	12
Beets*	spring	--	--	--	--	1	1	2	3	4
Cucumbers*	late spring	--	--	--	7	6	6	6	7	7
	early fall	--	--	--	--	1	1	1	1	2
Tomatoes*	late spring	--	--	--	4	5	4	5	6	5
Onions*	late spring	--	--	2	2	3	3	3	4	5
Garlic*	spring	--	--	--	--	--	1	2	1	1
Shallots*	spring	--	--	--	--	--	--	1	1	1
	winter	--	--	--	--	--	--	1	1	1
Eggplant*	summer	--	--	--	2	2	2	2	2	2
Green peppers*	early summer	--	--	--	1	2	1	2	2	2
Carrots*	winter	--	--	--	2	3	4	4	5	4
Spinach*	winter	--	--	--	4	3	3	3	3	3
Truck crops for	processing	--	--	--	--	27	36	33	34	34
Strawberries*	early spring	--	--	1	1	1	1	1	1	1
Oranges		--	--	5	4	3	4	5	5	5
Peaches		22	26	24	24	23	23	25	25	26
Pears		33	32	33	28	26	23	23	19	13
Pecans		--	--	5	4	3	4	4	4	4

* Rank among states having the same marketing season as Louisiana; rank is based on commercial production.

Source: Compiled from releases by the Bureau of Agricultural Economics, U. S. Department of Agriculture.

year only. The 1909-13 average volume of production was 59 per cent of the average in the base as compared with an average index of volume of 118 in 1947-51.

Production of cowpeas fluctuated widely from year to year and from cycle to cycle from 1925 to 1949. Production data indicate cowpeas production is a declining enterprise in Louisiana's agricultural economy. The index of volume of production was 34 in 1951, the smallest volume of record. The decline in volume of production averaged 1.3 index points per year from 1925 through 1949. The crop never has been one of the major cash income crops of the state.

The index of volume of production of corn averaged 108 (1935-39 = 100) in 1909-13 as compared with an average of 67 in 1947-51. Volume of production of corn from 1909 through 1951 may be divided into three varying periods: the first, 1909-30, was a period of decline in volume of production; the second, 1930-38, a period of irregular increase in volume of production; and the third, 1939-51, a period of decline in the volume of corn production (Table 6). The secular trend in volume of corn production was downward at an average rate of 0.8 index point. Volume of corn produced follows a cyclical pattern. There were 13 volume-of-production cycles completed, from trough through peak to trough, from 1909 through 1951. The average length of cycles was 3.2 years, with an average of 1.5 years increase in volume of production and an average decline of 1.8 years. Volume of corn production fluctuates widely from year to year on account of varying weather conditions.

The volume of production of oats did not vary greatly from 1909 through 1933. From 1933 through 1948 volume of production increased materially. Since 1948 there has been a sharp reduction in acreage and in volume of production of oats. The long-time trend in volume of production of oats was upward at an average annual rate of 4.7 index points. Production of oats expanded to the extent that the oat attained importance in the feed grain enterprise by 1948. Apparently the expansion in producion of oats is a result of curtailed acreage planted to corn.

The volume of production of hay increased irregularly from 1909 through 1951. The average annual rate of production in 1909-18 was 68 per cent of the volume average in 1935-39 as compared with an average of 114 per cent of the base average in the last ten years, 1924-51. Louisiana farmers produced an average of 68 per cent more hay in the last ten years than the average amount produced in the years 1909 through 1918. Increasing quantities of hay are produced for the beef cattle and dairy enterprises. The index of volume of hay production in Louisiana exceeded 100 first in 1939. Since 1939 it has been below 100 per cent of the average production in 1935-39 only one time, when it dropped to 98 in 1951.

Soybean production for beans was of little importance in the agricultural economy of Louisiana prior to 1924. In 1924 volume of production was 35 per cent of the average in 1935-39. As a result of increased demand for oil crops, production of soybeans has expanded greatly. Average production in 1924-28 amounted to 73 per cent of the average in 1935-39 as compared with an average of 268 per cent of that base in 1947-51. Soybean production increased materially between 1924 and 1950. The long-time trend in soybean production was upward at an average annual rate of 7.6 index points.

Peanut production is characterized by its tremendous changes in the volume of production from year to year. Apparently, peanut production is a declining enterprise even though it has never been a major crop in Louisiana. The volume of production of peanuts in 1909-13 averaged 71 per cent of the volume average in 1935-39 as compared with an average of 27 per cent in 1947-51. The volume of peanuts was the lowest of record in 1951 when the index of volume produced declined to 23.

Although production of Irish potatoes is common throughout the state, commercial production for the mid-spring market is limited to relatively few producers in small areas in South Louisiana. Acreage devoted to commercial production ranged from 12,000 to 20,000. The index of volume of production of potatoes averaged 49 (1935-39 = 100) from 1909 through 1913. The index of volume was above 100 only one time—in 1918 it was 108—until 1931, when 139 per cent of the base average was produced. This was the highest volume of record. The greatest average volume for a five-year period was from 1941 through 1945 when the index of volume averaged 113. The index of volume in the most recent five years averaged 46. Volume of production dropped to 29 per cent of the base average in 1951. Louisiana's rank among the states as a mid-spring Irish potato producer ranged from sixth to ninth from 1910 to 1950. The potato has ranged from eighth to seventeenth in economic importance among agricultural enterprises within the state. It is probable that Louisiana farmers will continue producing some potatoes for sale but the enterprise has declined drastically since 1944.

Louisiana ranked seventh, fourth, sixth, third, first, and first among the states in volume of sweet potato production in 1910, 1920, 1930, 1940, 1945, and 1950, respectively. The economic importance of sweet potatoes among Louisiana crops ranged from sixth to fourteenth from 1910 to 1950 (Table 9). The index of volume of sweet potato production in Louisiana fluctuated narrowly from 1909 to 1918, with an average annual index of 59 (1935-39 = 100) as compared with an average index of volume of production of 117 in the most recent ten years, 1942-51. From 1909 through 1918 an average of 59,500 acres of land were used in the production of sweet potatoes as compared with an average acreage of 97,600 acres from 1942 through 1951. The average yield per acre of sweet potatoes was 77.6 in 1909-18 as compared with an average yield of 95.0 bushels per acre in the latest ten years, 1942-51. These data indicate that on the average in the last ten years Louisiana farmers have used 64 per cent more land in sweet potato production than was used in 1909-18; that yield of sweet potatoes per acre is 22 per cent higher than it was 40 years ago; and that the volume of production of sweet potatoes is 98 per cent greater than the annual average of 40 years ago. The secular trend in volume of production of sweet potatoes is upward at the average annual rate of 1.7 index points. Sweet potato prices tend to exert an influence on the acreage planted to sweet potatoes the following year. In recent years increasing quantities of Louisiana sweet potatoes have been processed in canning for table use and in dehydration for livestock feed.

The only place in the world that Perique tobacco is grown is a small area in St. James Parish, Louisiana. Acreage of Perique tobacco ranged from 100 to 1100 between 1919 and 1951. Volume of production ranged from 35,000 pounds to 478,000 pounds. Innumerable unsuccessful attempts have been made to grow this tobacco in other tobacco-producing areas throughout the world. This tobacco is used largely as a blend with other tobaccos. The index of volume of production of Perique tobacco fluctuated from a high of 248 (1935-39 = 100) in 1922 to a low of 18 in 1934. The trend line from 1918 to 1951 was downward at an average annual rate of 2.9 index points. Definite cyclical movement in volume of production of this tobacco is observed. The tendency has been for increase in volume of production of Perique tobacco since 1940. Other tobaccos are not grown in Louisiana on a commercial scale.

Tung oil nut production on a commercial basis began in Louisiana about 1939, in which year 150 tons were marketed. The greatest volume of tung nuts of record in Louisiana was that of 1949, when marketings amounted to 25,200 tons. Cash income from marketings of tung nuts increased from $6,000 in 1939 to $1,613,000 in 1949. Because of a severe cold spell in blooming season the 1950 crop declined to 6,100 tons with a market value of $573,000. An even more unfavorable production season occurred in 1951, when volume dropped further to 2,200 tons with a value of production of $220,000.

The average of the indexes of volume of production of commercial truck crops was 49 (1935-39 = 100) from 1918 through 1922. The index of volume increased to above 100 in each of the four years 1926, 1927, 1928, and 1929. The volume of production fluctuated irregularly between indexes of 57 and 113 from 1929 through 1951. A rather drastic decline in volume of production of commercial truck crops occurred following 1945, the decline being from 130 per cent of the 1935-39 average volume in 1945 to 51 per cent of that average in 1951. Volume of production has declined continuously since 1945. Apparently commercial truck crops are finding it progressively more difficult to compete with other agricultural enterprises for land, labor, and capital required in their production.

Pecan production is a rapidly expanding enterprise in Louisiana. Production data show clearly the behavior pattern of alternate years of tree growth with light nut production and of light tree growth and heavy nut production. The smallest volume of production of pecans from 1919 through 1951 was in 1922 when only seven per cent of the 1935-39 average volume was produced, and the largest volume of pecan production of record was in 1948 when 228 per cent of the base average was produced. The secular trend in volume production is upward at an average annual rate of approximately 3.9 index points. The average of the indexes of volume of production in 1919-23 was 37 as compared with an average of 144 in 1947-51.

There are two separate crops of commercial snap beans produced in Louisiana. The volume of snap beans produced for the mid-spring market is much greater than the crop produced for the early fall market. The index of volume of production of mid-spring beans averaged 22 (1935-39 = 100) from 1918 through 1922. The average volume of production in the ten-year period 1929-38 was 94 per cent of the base average. Since 1938 volume of production declined; the index of volume in the latest five years, 1947-51, averaged 55. The lowest volume of production of record was the index of 15 in 1920 and the highest was 116 in 1938. The secular trend in volume of production of snap beans for the mid-spring market from 1919 through 1951 was upward at an average annual rate of 1.4 index points. The long-time rate of increase in volume of snap beans production for the early fall market averages 0.5 index point per year. The tendency has been a decline in volume of production since 1940. The index of volume of production of snap beans for the early fall market averaged 57 in the latest five years, 1947-51.

The volume of cabbage production fluctuates widely from year to year; however the variations are caused more from variations in weather conditions than from fluctuations in acreage set to cabbage. The index of volume of cabbage grown in Louisiana averaged 66 from 1918 through 1922 as compared with an average of 172 in the most recent five years, 1947-51. This high volume in the last five years was achieved despite the lowest volume of record in 1951 when the index of volume dropped to 41 as compared with 204 the previous year. The long-time trend in volume of cabbage production is upward at the average annual rate of 5.2 index points.

Commercial watermelon production statistics are available only since 1934. Production expanded rapidly from 1934 to 1937; since 1937 production has declined almost continuously. Volume of watermelon production for the market in 1951 was only 36 per cent of the average in 1935-39.

The volume of commercial beet production for the fresh vegetable market declined almost continuously from 1927 through 1951. The highest volume of production of record was that of 1928 when 234 per cent of the average annual volume in 1935-39 was produced. The smallest volume of production was in 1951 with 6 per cent of that average. Average volume of production in 1947-51 was 15 per cent of base average. The rate of decline in volume of beet production from 1927-51 was 8.0 index points per year.

The volume of spring cucumber production for the fresh market expanded irregularly from 1923 to 1950. The average increase in volume of production for the fresh market was 2.19 index points. Fall cucumber production for the fresh market expanded at a somewhat slower rate than that of the spring crop. The secular trend in volume of production for the fall market was upward at an average annual rate of 1.8 index points. Fall cucumber production for the fresh market is characterized by the wide fluctuations in the volume produced from year to year. The smallest volume produced from 1929 through 1951 was in 1934 with 62 per cent of the volume average in 1935-39. The highest volume of production was the 178 per cent of the base average in 1946. Volume declined from 178 per cent in 1946 to 67 per cent in 1947, since which time it increased from year to year to 123 per cent of the 1935-39 average in 1950 and again declined to 78 in 1951 (Table 6).

The volume of production of tomatoes for the fresh market expanded considerably from 1929 to 1940 and has declined steadily since that time. The index of volume of production of tomatoes for the fresh market averaged 58 (1935-39 = 100) in 1926-30. The volume increased to an average index of 108 in 1937-41 and then declined to an average of 51 in 1947-51. The volume of tomato production for the fresh market was 40 per cent of the 1935-39 average in 1951 (Table 6). This was the smallest volume of production of record.

The average index of volume of production of onions in 1918-22 was 155 (1935-39 = 100). The volume continued fairly heavy from 1918 through 1929, the average index being 200. The volume dropped from 199 per cent of the 1935-39 average in 1929 to 51 per cent of that level in 1930. Volume of production of onions continued low for seven years and again consistently ran above 100 for nine of the following ten years, 1937-46. The average index of volume for the most recent five years, 1947-51, was 75. Acreage devoted to commercial onion production ranged from 2,900 in 1927, when the index of volume of production was the highest of record at 235, to 500 acres in 1933, when the index of volume of production was 23. Yield per acre varied from 300, fifty-pound sacks in 1922 to 60 sacks in 1930. The long-time trend in volume of production of onions is downward at an average annual rate of 1.9 index points.

The garlic enterprise, although of minor importance to the agricultural economy of the state as a whole, is of considerable importance to some vegetable and truck farmers in the southern part of the state. The volume of garlic production has declined less since 1932 than other vegetable and truck crops. Acreage devoted to commercial garlic production ranged from 500 to 1,200 from 1932 through 1951. The index of volume of production of garlic has been 100 or more consistently since 1938. Louisiana regularly produces more garlic for the commercial trade than any other state.

Louisiana farmers produce greater volume of both winter and spring shallots than any other state. Acreage set to shallots has been fairly constant over the years but yield per acre varies considerably from year to year. Volume of production of winter shallots varies less than the spring crop. The spring crop has been smaller than the 1935-39 average in every year since 1942. The shallot crop ranked eighteenth, nineteenth, and twentieth, respectively, in economic importance among agricultural enterprises in Louisiana in 1940, 1945, and 1950. The index of volume of production of winter shallots was 89 in 1951 as compared with an index of 88 for spring shallots. The average index of volume of winter shallots in 1947-51 was 90 (1937-41 = 100) as compared with an average index of volume of spring shallots of 67 in 1947-51.

Commercial production of eggplants declined materially from 1925 to 1951. The index of volume of production of eggplants averaged 100 in 1925-29 as compared with an average index of volume of production of 57 in 1947-51. The rank of eggplants in economic importance among Louisiana's crops ranged from 32 to 42 from 1925 to 1950. Louisiana ranked second among the states in volume of eggplants produced for the market in each of the five-year periods from 1925 through 1950. It is probable that the volume of production is stabilized at about half the volume produced in the base period (1935-39 = 100).

Louisiana ranked 1, 2, 1, 2, 2, and 2 in 1925, 1930, 1935, 1940, 1945, and 1950, respectively, among the states in volume of production of early summer green pepper production. The rank of green peppers in economic importance among crops within the state varies from 21 to 31. The volume of production of green peppers for the fresh market varies widely from year to year with little long-time change in volume of production. The index of volume of production in 1950 was 98 as compared with an index of volume of 115 in 1951.

The economic importance of the carrot crop declined from 18 in 1925 to 37 in 1950 among agricultural enterprises in Louisiana. Louisiana carrot crop ranks from second to fifth among the states producing the winter carrot crop. The index of volume of production of carrots in Louisiana averaged 165 (1935-39 = 100) in 1923-32 as compared with an average index of 53 in 1942-51. The smallest volume of production of record was in 1951 with an index of volume of 27. The straight line trend computation shows volume of carrot production declining at an average annual rate of 5.8 index points. Acreage devoted to commercial carrot production declined from a high of 4,750 in 1927 to the lowest of record in 1951, when the acreage was 850.

Louisiana ranks third among the states as a commercial producer of winter spinach. Spinach ranges in rank from 33 to 44 among Louisiana crops as a revenue producer. The volume of production declined sharply from 1925 to 1951. The index of volume of production of spinach averaged 160 (1935-39 = 100) in 1925-29 as compared with an average index of 33 in 1947-51. There was a decline in volume of production of spinach each year from the preceding year from 1941 through 1951. The index of volume of production of spinach was 15 in 1951. The major part of spinach sales was to local merchants in recent years.

Production of truck crops for processing varied widely from 1928 through 1951. The secular trend in volume of production was upward at an average annual rate of 1.3 index points. The volume of production in 1950 was 105 per cent of the average volume in 1935-39 as compared with 55 per cent in 1951. The index of volume of production of truck crops for processing was above 55 in only one of the past four years. The average of the index of volume of production was 93 in 1928-32 as compared with an average of indexes of 73 in 1947-51.

Louisiana ranks first among the states in the production of early spring strawberries (Table 8). The strawberry crop varied from second to thirteenth in rank in economic importance among Louisiana crops from 1918 through 1950 (Table 7). The volume of strawberry production varies greatly from year to year in Louisiana. Eight cycles in volume of production were completed from 1916 to 1949. The average length of time in volume of production cycles, from trough through peak to trough, was 3.9 years, with an average length of increase of 1.8 years and an average time of decline in volume of 2.1 years. The greatest increase in volume of strawberry production in one year over the preceding year was from the index of volume of production of 83 in 1930 to an index of volume of 158 in 1931, an increase of 75 points, or 90 per cent. The greatest decline was from an index of volume of 130 in 1942 to an index of 51 in 1943, a decline of 79 points, or 61 per cent from the preceding year. The index of volume of production was below 100 from 1918 through 1927; in 11 of the next 15 years, 1928-1942, the index of volume of production was above 100. Volume of production has not been above 100 from 1942 through 1951. Volume of production expanded irregularly from 1918 to 1931. From 1931 to 1942 volume of production was at its highest, since which time there has been a tendency toward declines in volume of production. The index of volume of production averaged 46 in 1918-22 as compared with an average of 118 in 1930-34 and an average of 60 in 1947-51. The long-time trend in volume from 1918 to 1950, influenced by high production from 1928 to 1942, was upward at an average annual rate of 0.5 index point. Indications are that the volume of production in 1952 will be the smallest since 1920. The index of volume of production of strawberries was 51 in 1951, from an acreage of 24,000. The acreage planted to strawberries in 1952 is estimated at only 10,000, the smallest in more than 30 years.

Volume of orange production is characterized by its rapid expansion from 1919 to 1930. Production in 1919 amounted to only 13 per cent of the average annual volume in 1935-39. Increases in volume were consistent until 1930 when production was 102 per cent of the average for 1935-39. This period may be described as one in which new groves were coming into production. Production data indicate alternate years of heavy and light production although declines and increases from year to year are not as a rule very large. The average of indexes of production in 1919-23 was 19 as compared with an average of 117 in 1945-49. The secular trend in volume of oranges produced in Louisiana from 1919 to 1949 was upward at an average annual rate of 3.5 index points. Commercial orange production is confined to a narrow strip of land bordering on the Mississippi River below New Orleans. Material expansion in production is not likely because of limitations of suitable land in the producing area. Because of a severe freeze in the orange area early in 1951 the crop harvested declined to only 18 per cent of the 1935-39 average. Reports indicate that permanent injury was done to many of the groves, thereby making it likely that there will be a lower volume of production for the next several years.

Peach production varies more widely from year to year than most agricultural crops. The widest variation in volume from one year to the next was experienced from 1911 to 1912 with an index of volume of production of 65 in 1911 as compared with an index of 234 in 1912. Heaviest production was obtained in the early years of the period for which data are available. The average for the years 1909-13 was 143 per cent of the 1935-39 average as compared with an average volume of 124 per cent of that average in 1945-49. There was considerable decline in volume of peach production for five years from 1918 to 1923. Production continued irregularly lower for some years and then increased somewhat following 1932. The general average of production has been more or less stable since 1934.

The index of volume of pear production was below 55 from 1909 through 1929 and was above 100 the first time in 1934. Following 1933 volume of production of pears increased materially. Pear production is heavy one year and light the next, thereby indicating alternate years of tree growth and heavy fruit production. The index of volume of pear production averaged 26 in 1909-13 as compared with an average of 138 in 1947-51. The long-time trend in volume of production is upward at the average annual rate of 3.6 index points.

SUMMARY

A comparison of Agricultural activity in Louisiana now with the early years of the present century shows many improvements in the last fifty years. These improvements included the following:

1. The tenure situation has improved materially. 2. Subsistence farming is being replaced by commercial agriculture. More and more farmers are operating their farms as a business enterprise rather than a way of life. 3. Much progress has been made in farm management practices. 4. Mechanization has made it possible to accomplish much more with materially less labor. 5. More and better fertilizer and more attention to seed selection has contributed to higher yields per acre. 6. Research in plant and animal breeding has produced better plants and better animals. 7. Increasing attention is being given to soil conservation and erosion control and to improved pasture programs. 8. Ever increasing volumes of chemicals are being used in control of insect and disease pests, thereby increasing volume of agricultural production in Louisiana.

The volume of production on Louisiana farms has been increasing for many years. The average annual increase in total volume of agricultural production from 1909 through 1951 was 0.92 index point. The increases in volume of production in livestock enterprises since 1909 were greater than increases in the volume of production of field crops. The livestock enterprises showing the increases in volume of production were: beef cattle and calves, hogs, poultry and eggs, and dairy products. Sheep and lambs decreased in volume of production.

The field crops showing long-time trends in increases in volume of production were: cotton lint and cotton seed, rice, sugar cane for sugar and seed, soybeans, oats, pecans, pears, strawberries, and sweet potatoes. Cowpeas, sugar cane for syrup, corn, peanuts, and peaches decreased in volume of production.

The outlook is for a prosperous agriculture as long as inflation continues. When deflation begins, declining prices will reach farmers first and prices farmers receive will decline more and stay low longer than prices for other segments of the economy.

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Grassland Farming On Cutover Pineland Of West Louisiana

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Grassland Farming on Cutover Pineland of West Louisiana

By

H. E. Harris, A. H. McDaniel, and C. B. Roark*

INTRODUCTION

Grassland farming is a new approach to the economic use of the cutover lands of West Louisiana.

Since the cutting of the pine timber several million acres of West Louisiana land have been allowed to lie idle or partially idle growing scattered trees, grasses, and other native vegetation.

Cattle and sheep have grazed the open range since the timber was harvested. Good land management makes possible more efficient use of the land; half use or less is not enough to support the growing population.

When the once-abundant timber resources were gone, many former timber workers and sawmill employees, who were skilled in the lumber industry, were left to make their living from whatever source might be available to them. In order to make a living many of these people turned to agriculture and attempted to grow row crops.

Row crop general farming proved to be hazardous on these thin soils. These soils are subject to severe erosion, as a result of heavy rains. The row crop farmer on these hill soils, except possibly the truck crop farmer near a good market, is at a decided disadvantage under present conditions. He is attempting to produce products from thin soils, on rolling hillsides, and on small farms with small tools in competition with large farms on level fertile soil with large modern machinery.

The major soil types of the area include Bowie, Ruston, and Beauregard fine sandy loams. The top soil is generally a sandy loam, three to six inches in depth, while the sub-soils range from previous well-drained sandy clays to impervious clays lying in the lower poorly drained flat areas. These soils are deficient in organic matter, and are low in available nitrogen, phosphorus, calcium, and potassium.

The climate is mild and there is an average annual rainfall of more than 50 inches. The rainfall is irregular and every few years a flash flood of eight to ten inches or more may be expected within a period of 24 hours. During other seasons, especially in the fall of the year, there may be periods of several weeks with little or no rainfall. These extremes in the rainfall cycle make row crop farming especially hazardous.

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The Weather Bureau reports some of these irregularities as recorded by the weather station at Leesville. In 1948 the annual precipitation was 48.11 inches, while in 1949 it was 59.99 inches, or a difference of 11.88 inches. In 1950, generally considered a dry year locally, the total rainfall was 58.93 inches, or 5.59 inches above normal. But 44.11 inches fell during the first six months; there was a surplus above-normal for each of the first six months except March. During the last six months there was only 14.82 inches, or a below-normal rainfall for each of the last six months.

Farmers who started new pastures during the fall of 1950 were at a decided disadvantage because of the low rainfall during the last half of the year.

GRASSLAND FARMING

One of the most efficient means of using these soils is by building up the humus content and retaining a layer of sod to hold water, which in turn supports the sod. This is done through the process of building good pastures and harvesting them by grazing livestock.

Building up pastures requires the use of available minerals that are lacking in the soils in their native state, and the use of properly established improved grasses, clovers, and lespedeza or other legumes to supplement native grasses. By using the above practices, grazing has been produced during every month of the year. The production of winter grazing requires good management and a knowledge of when to graze and what to graze.

KINDS OF PASTURE

One pasture mixture is not enough. No single pasture plant or combination of plants has been found at this Station that will furnish grazing 365 days in the year on the same land. Seven pastures were fenced and grazed separately as a means of testing pasture plant mixtures that, when grazed in rotation, would lead toward a twelve months' grazing program.

The purpose of this study was to determine:

1. Which grasses and legumes grow well together to produce high yields.
2. The period of year they produce.
3. Pasture costs and returns per acre.

LAND PREPARATION AND STEPS USED IN ESTABLISHING A PASTURE

Land preparation on these seven pastures consisted of plowing under native vegetation in the summer, disking the land at least once (or twice where necessary), and dragging the surface smooth in preparation for a good seedbed and the operation of machinery.

Since fescue is a relatively new grass for this area, we use it together with Louisiana white clover or Louisiana white clover and oats to outline the steps used in establishing a pasture from range land.

1. Land plowed shallow and not below surface soil. 2. Disk land once or twice as needed. 3. The harrow aids in preparing a smooth surface. 4. The cultipacker leaves a firm ideal seedbed.

Fescue grass may be planted in September or about one month ahead of the time for planning white clover. This gives the grass a month longer to grow. But if clover is planted early with the grass, dry, hot weather often kills many of the young clover plants, causing a reduction in the stand or the necessity of planting heavy amounts of seed to allow for the dying out of the young plants.

Flat break the land in July. Broadcast 1½ to 2 tons of lime per acre, preferably two to three months before plowing land. Disk land in August; drag it down smooth. About September 15, apply broadcast a 50-100-50 fertilizer in one of the following or similiar mixtures:

1. 400 pounds of 2-12-12 and 500 pounds of basic slag, also 33 pounds of nitrogen (in either 100 pounds of ammonium nitrate or 200 pounds nitrate of soda).
2. 400 pounds of 12-12-12 and 500 pounds of basic slag.
3. 400 pounds of 12-24-12.

The above fertilizer application is for a first-year pasture. Disk fertilizer into the soil about September 15 and drag the land lightly with a board or other satisfactory drag. If the land is very rough, it should be dragged heavily before applying the fertilizer, then redragged lightly or harrowed after disking in the fertilizer.

About September 15 sow 10 to 12 pounds of fescue seed per acre. Fescue seeds are small and should be sown on the surface and pressed into the soil with a cultipacker. They may be planted with a Cultipacker Seeder.

About October 1 to 15, after the ground is thoroughly wet and preferably between showers, sow on this firm seedbed, which was cultipacked when fescue was planted, 4 to 6 pounds of inoculated Louisiana white clover seed per acre. If grazing is expected the first year, 2 bushels of oats may be added to the above mixture and covered sufficiently deep just ahead of planting the fescue. Both grass and clover may be planted with success in October by cultipacking the land and then sowing the seed and rolling the land again with the cultipacker.

The above fertilizer mixtures will not apply to all soils and are for general use only. Rates and kinds of fertility should be determined by a laboratory analysis of the soils to be treated.

FERTILIZATION

Research during the last few years has shown that most of the soils in the West Louisiana hill area are naturally deficient in lime, phosphate, potassium, and nitrogen. Adequate fertilization is one of the most important steps in their efficient use for the production of pastures.

These seven pastures were fertilized similarly in order to put them on a comparable basis. In the fall of 1948 they were limed at the rate of one to two tons per acre according to their needs. Fertilizer was applied at the rate of 500 pounds of 8-8-8 and 500 pounds of basic slag.

In the fall of 1949 500 pounds of 3-12-12 fertilizer were applied.

Lime and fertilizer should be applied uniformly.

In 1950 one-half ton of basic slag, 100 pounds of 60 per cent muriate of potash, and 133 pounds of 33.5 per cent nitrogen were applied.

Fertilizer used in 1951 was 200 pounds of 33.5 per cent nitrogen in the spring, and 500 pounds of 12-12-12 in the fall.

BEEF PRODUCED PER ACRE

Table I shows the yield of beef per acre for each of the seven pastures. It also shows the months in which gains were made.

Ladino Clover and Fescue Grass

This pasture furnishes its best grazing during the period of March 1 to July 1. Some grazing may be expected during winter under favorable weather conditions. During the two-year period 1950-51 the stand of Ladino clover diminished until most of the grazing was supplied by fescue during the second year. Ladino clover requires abundant moisture, and the stand was reduced by summer droughts. Two-year records show an average annual yield of 250 pounds of beef per acre.

Singletary Peas, Rye Grass, and Bermuda Grass

The Singletary pea is an annual legume that furnishes early grazing. Some years it may be grazed as early as January. Its earliness depends on adequate fertility and weather conditions. Peas may be grazed until about the middle of May.

TABLE 1.

Pounds of Beef per acre from Different Pasture Plant Mixtures Two-Year Average, 1950-1951

Month Grazed	Ladino Clover, Fescue	Singletary Peas, Rye Grass, Common Bermuda	Louisiana White Clover, Fescue	Crimson Clover, Fescue	La. White Clover, Dallis Grass, Fescue	Louisiana White Clover, Dallis Grass	La. White Clover, Dallis Grass, Rye Grass
Jan.	0	73	22	0	0	13	19
Feb.	0	31	38	0	0	18	38
March	87	45	126	134	96	7	101
April	60	46	115	93	103	51	117
May	51	33	85	118	92	26	60
June	35	12	40	61	9	42	45
July	0	35	14	0	10	106	55
Aug.	0	14	0	0	55	10	16
Sept.	0	31	0	0	0	31	16
Oct.	0	0	0	43	0	13	3
Nov.	17	51	29	0	14	12	47
Dec.	0	0	0	0	0	0	0
Two-Year average	250	371	469	454	379	329	517

This mixture has produced one of the longer growing season pastures. It should be grazed very carefully the first year, being sure a good seed crop of peas shatters to the ground.

Yields were 172 pounds per acre in 1950 and 570 pounds in 1951, or a two-year average yield of 371 pounds of beef per acre. The grazing is distributed over about eight or nine months of the year. During 1951 this pasture furnished 234 cow days grazing with an average daily gain per animal unit (cow equivalent) of 2.44 pounds.

Singletary peas work well in combination with rye grass. When they begin to form fruit pods, they cause a toxic condition in cattle. This toxic condition causes lameness, making it necessary to remove the animals from the pasture. Cattle appear to recover in a few days when grazed on another kind of pasture. Removing the livestock when pods begin to form on the plant makes possible a seed crop which, if allowed to shatter to the ground, comes up the following fall. This legume stores nitrogen in the soil which aids in the growth of Bermuda grass that follows during the summer.

Louisiana White Clover and Fescue Grass

This is an early pasture that may furnish light grazing as early as January, during a favorable season, and heavy grazing during March, April, and May. It may also furnish light grazing until August if there is sufficient moisture.

The yield was 370 pounds per acre in 1950 and 569 pounds per acre in 1951, or a two-year average yield of 469 pounds of beef per acre. During 1951 it provided 152 animal days grazing per acre, which resulted in an average daily gain of 3.74 pounds per animal unit.

Crimson Clover and Fescue Grass

This combination produces a heavy growth and may be grazed as early as January during a favorable growing season. This pasture furnished heavy grazing the first of March during the two-year period. Its heaviest yield was produced during March and April. Crimson clover seed matures during May. The pasture is allowed a few days rest while seeds are maturing so that plenty of seeds shatter to the ground to come up in the fall. After the seeds were mature the pasture was mowed and grazed again as soon as the grass had made sufficient growth.

The yield was 472 pounds per acre in 1950 and 436 pounds per acre in 1951, or a two-year average yield of 454 pounds of beef per acre. During 1951 it produced 116 animal days grazing per acre. The cattle made an average daily gain of 3.76 pounds per animal unit.

Louisiana White Clover, Dallis Grass, and Fescue Grass

This pasture furnished grazing from about March until September, depending upon the amount of moisture present. Earlier grazing may be expected during a mild winter.

Twenty pounds of fescue were drilled on the white clover-Dallis grass sod in the fall of 1949. The season was very dry and the fescue stand was thin. In the fall of 1950 eight additional pounds were drilled in. It has been difficult to established and maintain fescue planted on sod. The yield was 427 pounds per acre in 1950 and 331 pounds in 1951, or a two-year average yield of 379 pounds of beef per acre. This pasture furnished 192 animal days grazing per acre in 1951 with an average daily gain per animal unit of 1.73 pounds.

Louisiana White Clover, Dallis Grass, and Rye Grass Compared with Louisiana White Clover and Dallis Grass Only

Two 15-acre Louisiana white clover and Dallis grass pastures were plowed, planted, fertilized, and seeded alike in the fall of 1948. Both pastures were fertilized alike thereafter.

In September, 1949 and again in 1950 15 to 18 pounds of rye grass seed to the acre were lightly drilled into the sod on one of the pastures, while the other remained in white clover and Dallis grass only.

TABLE II
Effects of Rye Grass on Yield of Beef

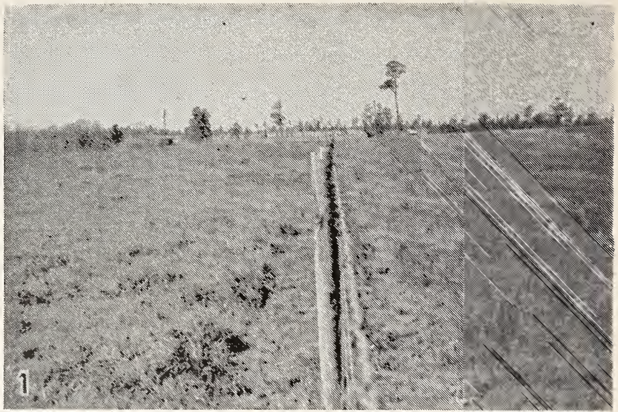
Month	Dallis Grass, Louisiana White Clover (Two-Year Average, 1950-1951)	Dallis Grass, La. White Clover, Rye Grass (Two-Year Average, 1950-1951)	Increase or Decrease in Yield Due to Rye Grass
January	13	19	6
February	18	38	20
March	7	102	95
April	51	117	66
May	26	60	34
June	42	45	3
July	106	55	—51
August	10	15	5
September	31	16	—15
October	13	3	—10
November	12	47	35
December	0	0	0
Total	329 lbs.	517 lbs.	118 lbs.

A Louisiana white clover—Dallis grass pasture where rye grass was drilled on the sod each September produced 442 pounds of beef per acre in 1950 and 593 pounds in 1951, or a two-year average yield of 517 pounds per acre as shown in Table II.

In 1951, the rye grass combination furnished 223 cow days grazing per acre with an average daily gain of 2.66 pounds.

In the pasture containing white clover and Dallis grass only, the yield was 337 pounds per acre in 1950 and 322 pounds in 1951, or a two-year average yield of 329 pounds per acre. During 1951 this pasture furnished 159 days grazing with an average gain of 2.03 pounds a day.

1. Rye grass on the left, winter weeds on the right. 2. Rye grass retards the growth of winter weeds. Grazing allows the clover a chance to develop. 3. Tall winter weeds crowd out the clover and must be mowed to allow the clover to come through.



The addition of rye grass, seeded annually at a cost for seed of about $2.50 per acre, increased the average annual gain of beef by 188 pounds per acre. The extra cost for seed was less than two cents a pound for the additional 188 pounds of beef produced.

Most of this increase in yield came during the period from November 1 to May 1. After May the rye grass died out and was gradually replaced by Dallis grass. The pasture that had no rye grass gave a little higher yield during the period from July 1 to November 1.

During 1951, the pasture containing rye grass carried 40 per cent more animal units per acre, or furnished 40 per cent more days grazing than the pasture without rye grass.

PASTURE COSTS AND RETURNS

In arriving at the costs of pastures it was assumed that it is necessary to replow the land and reseed pastures every third year. Present conditions of the pastures indicate that this assumption may be incorrect, but some basis has to be used to arrive at costs. This test has not been in effect long enough to determine how long these pastures can be maintained. If pastures need replowing only every five or ten years or even longer the cost would be reduced accordingly.

Average Annual Costs

Fertilizer Cost, 1950-51		Fertilizer Cost, 1951-52	
½ ton basic slag	$10.00	500 lbs. 12-12-12	$19.20
100 lbs. 60% potash	2.60	100 lbs. 33.5% nitrate	3.61
333 lbs. 33.5% nitrate	12.33		
Total	$24.93	Total	$22.81

Average annual fertilizer cost	$23.87
Lime applied every third year equals annual cost of	3.41
Land preparation every third year equals annual cost of	5.00
Clover seed, 5 lbs. @ 80c every third year equals cost of	1.33
Dallis grass seed, 15 lbs. @ 80c every third year equals annual cost	4.00
Rye grass seed, 20 lbs. @ 12.5c equals annual cost	2.50
Mowing three times annually	3.00
Average annual cost per acre	$43.11

Average Annual Returns

The seven pastures containing 59 acres gave a two-year average yield of 405 pounds of beef per acre.

405 pounds beef @ 26¼c	$106.31
Less average annual costs	$ 43.11
Average annual returns per acre	$ 63.20

The above costs are total costs and do not take into consideration assistance available from Production and Marketing Administration.

PASTURE USE AND MANAGEMENT

Management is the most important factor in determining whether or not a pasture makes a profit. Soil moisture and fertilization are the major controlling factors that determine the production of a pasture.

During 1949 these pastures were used for producing seed and for limited grazing.

In 1950 and 1951 they were grazed and cattle weights were kept in order to measure their yield. The yield was measured in pounds of beef per acre. Good grade cows and calves of the Aberdeen Angus and Hereford breeds were used to measure yields. Cattle were weighed at the end of each calendar month and changed from one pasture to another. Cattle, were rotated from pasture to pasture in an attempt to eliminate differences in cattle being used to determine yields.

When on good pastures heifers graze only about five or six hours during the day.

The number of acres necessary to support a cow and her calf will vary from month to month and year to year. There are periods during March, April, and May when an acre may be too much for a cow and her calf. After July the cow alone may need as much as two additional acres during periods of severe drought.

Where all pastures are seeded to the same mixture, the available grazing tends to be exceedingly high during the peak season of production and very low during other periods of the year. Three plants in the same mixture have worked well on the trails made at this Station. The two sets of plant combinations giving the longest growing period have been: 1, Louisiana white clover, Dallis grass, and rye grass; 2, Singletary peas, rye grass, and Bermuda grass.

Pastures are grazed heavily during their peak season, but good management requires a close watch in order to avoid over grazing which results in feed infestation at a later period.

During winter the cattle are fed grass and legume mixed hay and cottonseed cake or meal. The quantity depends on the amount of available grazing. Cattle are not fed while on pasture under grazing test. Bulls are fed a special ration. They are especially well fed for a period of about three months prior to the breeding season and during breeding season. After breeding season a good pasture may be sufficient. Cattle have free access to a mineral supplement consisting of phosphorus, calcium, and salt at all times.

Consistent heavy annual applications of a complete fertilizer on limed soil for a period of three or four years has resulted in a good pasture of Louisiana white clover, Dallis grass, and native grasses without plowing the land. Plowing and preparing a good seedbed has made possible a pasture of about the same grazing capacity within a period of four to six months.

Clovers and winter grasses, such as rye and fescue, are planted in the fall. Lespedeza and summer grasses, like Dallis grass, Bermuda and carpet, are planted in the spring.

Where pastures are established by plowing, care should be taken to plow shallow and not below the depth of the surface soil.

Since most of the cattlemen of West Louisiana operate on a cow and calf basis, the data shown here are also on that basis. In that way the results here are directly applicable to the stockman's type of operation.

BLOAT

Bloat in cattle has been studied at this Station in connection with other pasture and livestock problems.

Its occurrence has been prevented by the use of a good stand and a continuous growth of grass interplanted with the clover during the entire clover growing season.

SUMMARY AND CONCLUSIONS

This study deals with grassland farming as it relates to the use of the cutover land of West Louisiana.

Seven pastures were planted to different mixtures and grazed by cows and calves to measure their returns in pounds of beef per acre.

Louisiana white clover and Dallis grass in which rye grass was sown each September gave the highest two-year average yield, 517 pounds of beef per acre. This was the best pasture mixture used. This mixture also produced the longest grazing season, approximately ten months. It produced 188 pounds more beef to the acre than a similar Louisiana white clover and Dallis grass pasture that did not have rye grass seeded in the fall. The additional rye grass resulted in a 57 per cent increase in beef yield over the two-year period. The pasture without rye grass produced a two-year average yield of 329 pounds per acre.

Louisiana white clover and fescue grass produced a two-year average yield of 469 pounds of beef per acre. This is a good combination for producing early grazing. This pasture produced grazing between November and July.

The Ladino clover and fescue grass pasture furnished most of its grazing from March through June. During 1950 and 1951 the clover stand was materially reduced as a result of dry weather. The two-year average yield was 250 pounds per acre.

Singletary peas, rye grass, and common Bermuda grass is one of the best combinations. This mixture furnished grazing for about ten months of the year. The two-year average yield was 371 pounds of beef per acre.

Louisiana white clover and fescue makes a very productive early pasture. It may be expected to furnish heavy grazing in March, April, and May, depending upon weather conditions. The two-year average yield was 469 pounds.

Crimson clover and fescue grass furnishes heavy grazing during March and April. The two-year average yield was 454 pounds of beef per acre. Most of the grazing was produced between February and June. Earlier grazing can be expected under favorable weather conditions. For greatest efficiency this pasture requires heavy grazing during its peak season.

The two-year average yield for Louisiana white clover, Dallis grass, and fescue grass was 379 pounds of beef per acre. Heaviest grazing is furnished from March through August. This is a good combination. More time is needed to study its possibilities.

The seven pastures produced a two-year average yield of 405 pounds of beef per acre. The annual cost for lime, fertilizer, seed, and mowing was $44.91. The annual return per acre above these costs was $61.40.

Use of the seven pastures in rotation with native grasses, native grasses and lespedeza, or Dallis grass and lespedeza has furnished grazing during every month of the year.

Since more than 95 per cent of Louisiana's beef cattle feed comes from grasses and forage crops, one of the most efficient means found thus far for using these lands is through the use of productive pasture grazed by good livestock.

Feed produced from the soil, grazed by good livestock twelve months of the year, on pastures spotted throughout a new forest that furnishes shelter for livestock while growing a profitable crop of trees, is a sound approach to the economic use of the rolling plains of West Louisiana.

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June 1952

Cattle Bloat on Clover Pastures

By

H. E. HARRIS, A. H. McDANIEL AND C. B. ROARK

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATION
W. G. TAGGART, *Director*

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Cattle Bloat on Clover Pastures*

By

H. E. Harris, A. H. McDaniel, and C. B. Roark†

INTRODUCTION

Bloat is a livestock problem that causes a heavy annual loss to stockmen. In Louisiana it is prevalent in the River Delta areas, but it is also a serious problem on the better developed clover pastures of the upland areas.

A study of bloat in cattle has been made at this Station along with the study of other factors in the management of highly productive pastures. A heavy growth of clover on these West Louisiana hill soils has caused severe cases of bloat and death from bloat to five head of cattle over a period of four years in an annual herd of about one hundred head of cattle.

The original cows of this herd were obtained from Texas and Oklahoma. Both the Aberdeen Angus and Hereford breeds were used in about equal numbers. This study involved the use of about 100 head of cows, calves, bulls, and heifer yearlings.

Although these cattle have been grazed on clover or clover and grass as early as January, they have shown little or no effects from bloat until about the first of April and after they had put on considerable flesh and the clover pasture was well developed.

Seven pastures were used in this study. Bloat has occurred in three of the seven. No symptoms of bloat have been observed in the other four. All pastures were grazed during the bloat season.

Cattle were turned on young, lush, heavy growths of clover or clover and grass mixture without regard for prior grazing or feeding. They were not given preventive measures or feed of any kind, unless they happened to be getting hay before being turned on pasture at the beginning of the grazing season. Cattle were turned on these pastures during all times of day and during all kinds of weather. They were allowed to graze at will day or night regardless of weather.

A sudden case of bloat has not developed during this study as a result of having suddenly turned cows on a good growth of any kind of pasture. It was always after they had been on a pasture several weeks, that they began to show symptoms of bloat.

Repeated cases of cows suffering from bloat have been relieved by turning the animals on a grass mixed pasture. As long as the cow remained on the grass and clover mixed pasture she suffered no trouble from bloat, but when returned to the clover pasture she suffered a recurrence of bloat until removed.

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*Preliminary report.

†Research Associate in Agronomy, Assistant Animal Husbandman, and Superintendent, respectively.

BLOAT PRODUCING PASTURES

The three pastures where bloat occurred were as follows:

1. White clover, Dallis grass (warm season), and Bermuda grass (warm season).
2. White clover, Dallis grass (warm season), and an unsatisfactory stand of rye grass (cool season).
3. White clover, Dallis grass (warm season), and a poor stand of fescue grass (cool season).

Bloat occurred in the white clover, Dallis grass, and Bermuda grass pasture in the early spring while there was an almost pure growth of clover and before the two warm season grasses had developed sufficiently to counteract the effects of the clover.

Later as the ground warmed up these grasses pushed through the clover and developed a balance between the grass and clover. At this stage of the grass growth bloat disappeared and even though there was a heavier growth of clover than previously, while bloat was prevalent, it was no longer easy for a cow to get a bite of clover without also getting grass with the clover. Bloat did not recur in this pasture after the grasses had made sufficient growth to balance with the clover.

In the second pasture, containing both rye grass and Dallis grass, there was a good stand and growth of rye grass except in an area of about one-half acre where there was no rye grass present. This gave opportunity for cattle to graze during early spring on a pure stand of clover. One case of bloat developed in this pasture. Later when the Dallis grass had developed, no further symptoms of bloat occurred.

Although the third pasture listed above contained fescue, a cool season grass, the stand of this grass was poor and there were areas of clover in which there was an insufficient stand or growth of grass. Later as the Dallis grass developed in this pasture, cows could get a balance of clover and grass and the occurrence of bloat disappeared.

NON-BLOAT PRODUCING PASTURES

The four pastures where bloat did not occur were:

1. Ladino clover and fescue grass.
2. Singletary peas and rye grass.
3. Louisiana white clover and fescue grass.
4. Crimson clover and fescue grass.

Each of the above four pastures contained a cool season grass, either fescue or rye grass. Cool season grasses are important because they develop early and come into production with the clover. Fescue and rye grass make their main growth while clover makes its growth. As soon as warm season grasses develop to the extent that they produce a good mixture of about half grass and half clover, the effects of bloat disappear equally as well in pastures containing warm season grasses as in the case of cool season grasses.

The proportion of grass to clover can best be maintained by an adequate supply of fertilizer of the right kind applied at the right time.

EFFECT OF NITRATE ON A CLOVER-GRASS MIXTURE

The percentage of grass in these pastures was influenced by the rate of seeding, but the level of nitrate in the soil had an even greater influence.

An experiment involving a ten-acre pasture was set up to determine the effects of different rates of nitrate on a Louisiana white clover and fescue pasture. Seeds were planted at the rate of five pounds of clover and twelve pounds of Alta fescue grass per acre in October. Fertilizer was applied at the rate of two tons of lime, one-half ton of basic slag, and 500 pounds of 3-12-12 mixed fertilizer per acre before planting.

This area was divided into plots of seven replications. During December, and after the grass was up to a good stand, the following rates of ammonium nitrate were used as a top-dressing:

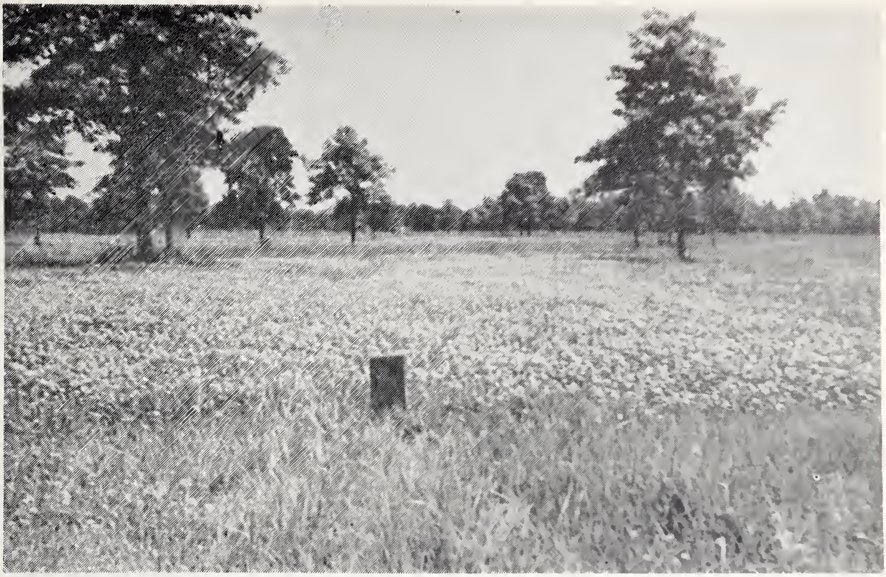
1. No top-dressing.
2. 100 pounds ammonium nitrate, or 33.5 pounds of N.
3. 200 pounds ammonium nitrate, or 67 pounds of N.
4. 300 pounds ammonium nitrate, or 100.5 pounds of N.
5. 400 pounds ammonium nitrate, or 134.0 pounds of N.

The results for two years showed that fescue came to a good stand on all plots. But the rate of its survival was in proportion to the amount of nitrate used as a top-dressing. As the rate of nitrate increased, the percentage of grass increased.

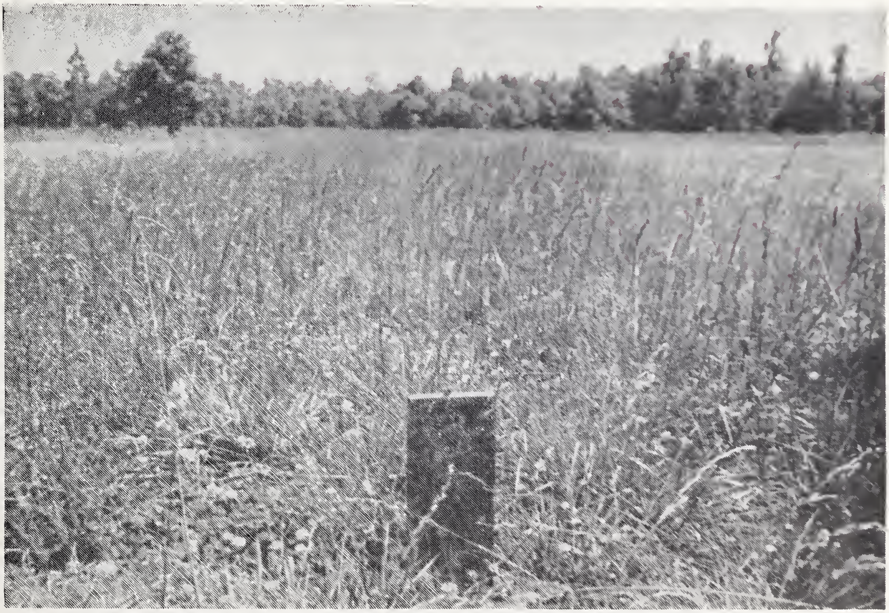
Where no top-dressing of nitrate was used the fescue died out and a solid stand of clover developed.

Where 100 pounds of ammonium nitrate were used only about half enough fescue survived.

Beyond the stake, where 200 pounds of ammonium nitrate were used, the mixture of fescue and clover was about right.



The 300 pounds of ammonium nitrate used in the foreground almost crowded out the clover. Beyond the stake where no top-dressing was used the clover crowded out the grass.



Where 400 pounds of ammonium nitrate were used, the clover plants were very sparse, as is evident by the few clover blossoms.

SUMMARY AND CONCLUSIONS

Bloat may be a serious problem wherever the soil is sufficiently fertile to produec a heavy growth of clover. It has been controlled on the hill soils at the West Louisiana Experiment Station by maintaining a good stand and growth of a cool season grass, or of both a cool season and a warm season grass grown interplanted with the clover.

Two of the best cool season grasses to grow with clover at this location are fescue and rye grass. Two of the best warm season grasses are Dallis grass and Bermuda grass. There should be more than one pasture on each farm. Two good clover-grass pastures are: 1. White clover, rye grass, and Dallis grass; 2. White clover, fescue, and Dallis grass or Bermuda grass.

A small area of a pure stand of clover may continue to cause bloat even though the animal has access to large areas of a well developed grass and clover mixture in the remainder of the pasture.

Repeated cases of cows suffering from bloat have been relieved by turning the animals on a grass mixed pasture. In acute cases the animal was first relieved, then put on grass mixed pasture. As long as the cow remained on the grass mixed pasture she suffered no trouble from bloat, but when returned to the clover pasture she suffered a recurrence of bloat until removed.

For most satisfactory results in producing a clover-grass pasture, balance should be maintained in the fertility level of the soil. Heavy applications of one fertilizer is poor economy. Soils should be tested for their fertilizer needs in a soils laboratory.

Heavy rates of nitrogen should not be used, until the lime, phosphate, and potassium needs of the soil have been met. The use of excessive rates of nitrogen without first meeting the mineral needs may prove disappointing. Livestock must have an adequate supply of minerals in order to produce bones and maintain good health.

The important thing to remember is to maintain a good stand and growth of some kind of grass on every square foot of clover pasture during the entire clover growing season.

Farmers' Cooperative Credit Institutions n Louisiana

By
Bueford M. Gile and Olin B. Quinn

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Louisiana State University
and
Agricultural and Mechanical College

Agricultural Experiment Station
W. G. Taggart, *Director*

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Farmers' Cooperative Credit Institutions In Louisiana

By

Bueford M. Gile and Olin B. Quinn

COOPERATIVE CREDIT FOR AGRICULTURE

The cooperative credit system which functions for farmers in Louisiana was developed to alleviate an unsatisfactory condition that formerly prevailed in many farming areas. The terms of available real estate and operating capital loans were not suited to the biological nature of farm production, interest rates were excessive, and funds available for investment were frequently not accessible to the individual farmer needing a loan. The short maturity terms of real estate loans resulted in many renewals before final liquidation and sometimes contributed to foreclosure.

By 1900, the supply of free or nearly free fertile lands of the Preemption and Homesteading periods was exhausted, and young farmers wishing to become owners had to use credit. As the capital required for ownership and operation of the family farm increased in amount, the defects of the farm credit situation became more and more a matter of public concern. Frequent renewals of farm mortgage loans meant recurring costs for commissions, title examinations, and filing fees. These costs together with high interest charges became a burden on farmers and a deterrence to rural progress and development and resulted in congressional action.

The oldest unit of the cooperative farm credit system was authorized by the Federal Farm Loan Act of 1916. Among other things the Act of 1916 provided for 12 regional Federal land banks and authorized the organization of national farm loan associations by farmers for the purpose of obtaining amortized loans secured by a first mortgage on farm real estate.

Short-term credit for farm production and credit to finance the orderly marketing of farm products was authorized by the Farm Credit Act of 1933. Cooperative farm credit institutions are distinguished from other sources of farm loans by ownership and control being vested in the borrowers. With one exception, the agricultural credit institutions in Louisiana engaged exclusively in extending farm loans are part of the Federal credit system for agriculture.

Since 1933, the general supervision of cooperative farm credit in Alabama, Louisiana, and Mississippi has been vested in the regional office of the Farm Credit Administration located in New Orleans. The Federal Land Bank of New Orleans is concerned with farm real estate loans administered through local national farm loan associations. The

Production Credit Corporation of New Orleans exercises general supervision over farm production loans extended by local production credit associations. The Bank for Cooperatives of New Orleans makes loans to cooperative business organizations of farmers, but is not authorized to make loans direct to individual farmers. The Federal Intermediate Credit Bank of New Orleans is one of 12 regional banks created by the Federal Intermediate Credit Act of 1923. It facilitates the round-trip flow of short-term investment funds from the money centers to farmers needing credit for operating purposes. It does this by discounting for rural financial institutions interest bearing notes representing loans made to farmers for the growing and marketing of agricultural products.

NATIONAL FARM LOAN ASSOCIATIONS

There were 21 national farm loan associations in Louisiana in June 1951 with loans outstanding in the amount of $12,553,650. While there

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NATIONAL FARM LOAN ASSOCIATIONS, LOUISIANA, 1952

(Dates pertain to consolidations from the original associations, the earliest of which were organized in 1917. Name refers to executive officer.)

1. (a) Acadia National Farm Loan Association, (1937) Crowley, G. J. Wyatt
   (b) Lafayette Parish National Farm Loan Association, (1918) Crowley, G. J. Wyatt
   (c) Vermilion National Farm Loan Association, (1938) Crowley, G. J. Wyatt
2. B. L. and J. National Farm Loan Association, (1947) Arcadia, A. L. Coon
3. (a) DeSoto National Farm Loan Association, (1938) Shreveport, A. W. Cook
   (b) Northwest Louisiana National Farm Loan Association, (1949) Shreveport, A. W. Cook
4. Southwest Louisiana National Farm Loan Association, (1947) Lake Charles, J. B. Trahan, Jr.
5. Baton Rouge National Farm Loan Association, (1946) Baton Rouge, C. C. Reddell
6. Northeast Louisiana National Farm Loan Association, (1950) Lake Providence, J. S. Green
7. (a) Teche National Farm Loan Association, (1942) New Iberia, L. J. LeGendre
   (b) St. Martin National Farm Loan Association, (1917) New Iberia, L. J. LeGendre
   (c) Jeanerette National Farm Loan Association, (1917) New Iberia, L. J. LeGendre
8. Thibodaux National Farm Loan Association, (1950) Thibodaux, J. K. Schwarzenbach
9. Natchitoches National Farm Loan Association, (1946) Natchitoches, E. M. Rice
10. Ouachita Valley National Farm Loan Association, (1945) Monroe, A. C. Ransom
11. Alexandria National Farm Loan Association, (1943) Alexandria, J. W. Hickman
12. (a) Franklin Parish National Farm Loan Association, (1917) Rayville, G. L. Gladney
    (b) Richland Parish National Farm Loan Association, (1944) Rayville, G. L. Gladney
13. (a) Marksville National Farm Loan Association, (1917) Opelousas, R. D. Lamson
    (b) St. Landry National Farm Loan Association, (1943) Opelousas, R. D. Lamson
14. Amite National Farm Loan Association, (1945) Amite, Rogers Dodson

are 21 associations with corporate identity, there are only 14 main offices or NFLA districts as there are five districts in which a group of associations have agreed to operate jointly with only one secretary-treasurer. (See list of associations on Page 4.) For the convenience of farmers living some distance from the main office, there are 43 field offices or places where business may be transacted at stated times (Figure 1).

Each NFLA is separately chartered and has its own board of directors elected by the members. Officials for managing the affairs of the association are employed by the directors. The first national farm loan

National Farm Loan Associations in Louisiana

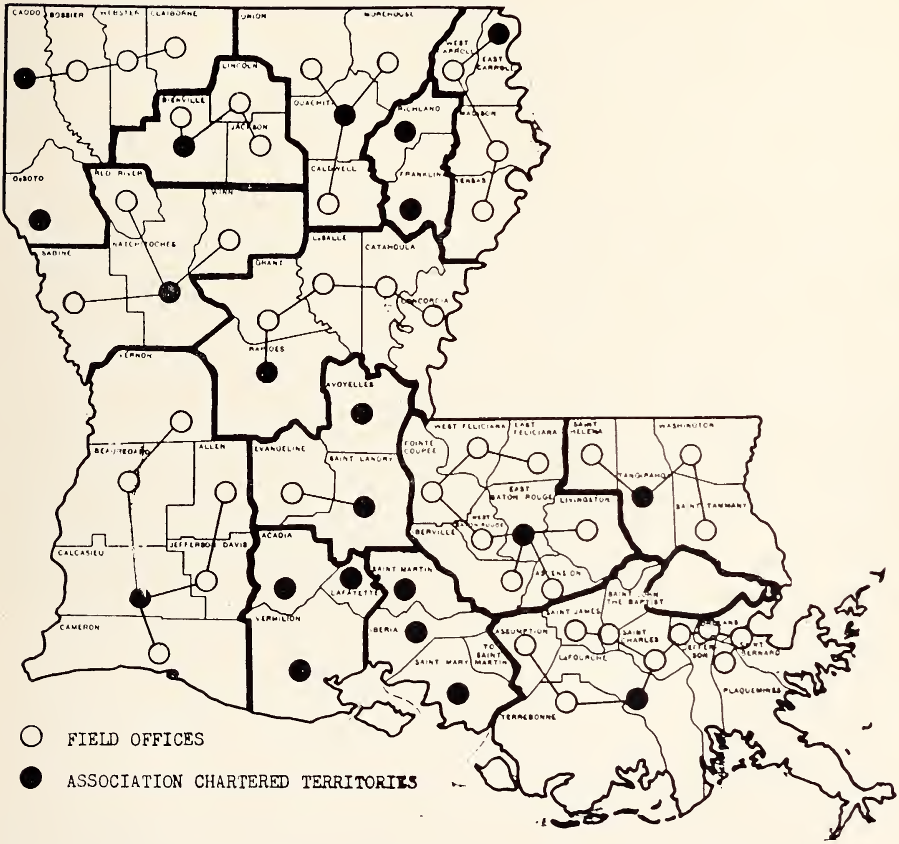

Figure 1. On June 30, 1951, the national farm loan associations in Louisiana had loans outstanding in the amount of $12,553,650. Each solid circle represents an incorporated national farm loan association and the open circles show the location of 43 field offices. Where there is only one solid black circle in a district bounded by heavy black lines, it shows the approximate location of the main office. Where more than one solid black circle is within a district, each association has designated loaning territory, but there is only one main office.

association was chartered in 1917, and the number of associations continued to increase until about 1926 when there were 80 associations in Louisiana. Many of the 80 associations had a small volume of loans and insufficient income to support the quality of management required. Since 1935 the associations have gradually been grouped and consolidated and the 21 associations remaining in 1951 were financially sound and had sufficient income to support competent management (Table 1).

National farm loan associations in Louisiana had 5,109 members on June 30, 1951. The associations furnish the contact between farmers needing credit and loan funds available for investment in the various centers where liquid capital tends to accumulate. It is their function to obtain farm mortgage credit service for farmers through the Federal Land Bank of New Orleans, endorse loans granted, and to give authorized service to loans outstanding. The funds for the Land Bank's lending operations are obtained largely by the sale of bonds to institutions with funds to invest. The maximum loan which may be made to one individual is $100,000. Persons engaged in farming or shortly to become

Table I. Loans Made Through National Farm Loan Associations in Louisiana and Financed Through the Federal Land Bank of New Orleans, 1920-51

Year[1]	National farm loan associations	Federal Land Bank loans				Land Bank Commissioner loans closed to farmers	
		Closed	Amount closed	Accumulative unpaid balance			
	Number	Number	Dollars	Number	Dollars	Number	Dollars
1920	68	xx	1,191,550	3,321	5,604,065	[3]	[3]
1925	79	2240	5,579,500	11,749	28,009,119	[3]	[3]
1930	80	238	570,500	12,813	27,800,448	[3]	[3]
1933	80	27	66,500	11,993	23,796,939	128	112,550
1934	80	911	2,823,500	12,505	25,046,874	3,954	4,573,100
1935	80	106	549,500	11,872	24,055,315	516	806,350
1937	79	112	433,200	10,786	20,939,025	190	264,725
1940	61	304	340,700	10,280	19,949,617	408	513,900
1941	61	244	1,137,400	9,873	18,728,703	310	465,800
1942	56	142	719,800	9,129	16,936,398	164	294,300
1943	38	90	441,300[2]	8,736	16,263,788	95	177,500[2]
1944	35	149	774,700	7,583	14,098,244	140	284,100
1945	32	216	986,400	6,592	12,519,069	219	376,600
1946	28	346	1,626,095	5,860	11,924,563	205	211,360
1947	25	508	2,094,160	5,538	11,935,762	295	228,655
1948	25	438	1,603,100	5,299	11,696,725	12	25,875
1949	24	487	1,948,580	5,196	11,820,317	----	[3]
1950	21	578	2,143,330	5,237	12,400,585	----	[3]
1951	21	469	1,802,170	5,109	12,553,650	----	[3]

Source: Annual reports of Federal Farm Loan Board, Farm Credit Administration and data furnished by courtesy of the Federal Land Bank of New Orleans.

[1] Since 1943, the data shown are for the year ending June 30. Prior to 1943 there is some variation, but largely the data are for the calendar year. Unpaid balances are as of the last day of the year as reported. [2] Loans closed January 1 through June 30, 1943. [3] No commissioner loans closed prior to 1933 and no new commitments were made after June 30, 1947. The unpaid balance of "Commissioner Loans" outstanding in Louisiana as of June 30, 1951, was $480,266.

so engaged, or who derive the principal part of their income from farming operations are eligible borrowers. The loans are limited to first mortgage loans in amounts not in excess of 65 per cent of the normal value of the farm real estate as determined by appraisal. At the present time, no loan is closed unless it is recommended by the local association concerned.

Stock ownership by members is one of the basic cooperative features of the Land Bank System. Each member of a NFLA is required to own stock in the association in an amount equal to 5 per cent of the loan granted. The association in turn subscribes to an equal amount of stock in the Federal Land Bank of New Orleans. When a farmer pays off his loan, his stock is cancelled and its value returned to him. In the case of loans made since May 1933, the maximum liability of each borrower for losses on the loans of other members is limited to the amount of stock he owns. There is still a double liability on all stock arising out of outstanding loans made prior to June 1933.

Purpose of Loans

Land bank loans may be used for the purchase of farms, the enlargement of owned farms, to refinance existing debts, and for any other agricultural purpose, such as the construction or repair of farm buildings, the improvement or conservation of farm land, and the purchase of machinery, fertilizers, and livestock.

Interest Rates and Loan Costs

Since 1935 the contract rate of interest paid by the borrower in Louisiana for a land bank loan has been 4 per cent. If the rate required to sell new issues of Federal land bank bonds at par should rise substantially, the rate paid by new borrowers would rise, since the cooperative farm loan system furnishes credit at cost. As compared with the rates paid prior to the establishment of the Federal farm loan system, the interest rate on farm real estate loans in recent years has been very low.

At the time of filing an application for a real estate loan of less than $500, the applicant pays an application fee of one per cent and an appraisal fee of five dollars. On loans from $500 to $1,000, the application and appraisal fees are five dollars each, and for loans over $1,000, the application fee is five dollars and the appraisal fee is ten dollars. The national farm loan association retains the application fee as income and sends the appraisal charge to the Federal Land Bank of New Orleans to help defray the expenses of appraisal.

In addition to the fees indicated above, there are certain costs which are incident to a mortgage loan from any source. After the loan is approved for closing, the borrower must furnish an abstract of title approved by an attorney and pay the fees charged for recording by the clerk of court. The fees charged for recording a farm mortgage are reported to vary from $4.50 to $21.00 depending on the number of words recorded and some other factors. The recorders may legally charge 25 cents per 100 words for recording and also charge for the cancellation of any former mortgages that have been paid but not satisfied on the record.

Table 2. Example of Loan Amortization Table—Even-Payment Plan, Principal $1,000, Interest Rate 4 Per Cent, Annual Installments, 35 Years

Installments		Interest	Payment on principal	Principal still unpaid
Number	Amount			
1	$54.00	$40.00	$14.00	$986.00
2	54.00	39.44	14.56	971.44
3	54.00	38.86	15.14	956.30
4	54.00	38.25	15.75	940.55
5	54.00	37.62	16.38	924.17
6	54.00	36.97	17.03	907.14
7	54.00	36.29	17.71	889.43
8	54.00	35.58	18.42	871.01
9	54.00	34.84	19.16	851.85
10	54.00	34.07	19.93	831.92
----	....	....	....	....
20	54.00	24.51	29 49	583.14
21	54.00	23.33	30.67	552.47
22	54.00	22.10	31.90	520.57
23	54.00	20.82	33.18	487.39
24	54.00	19.50	34.50	452.89
----	---- ----	....	....	....
31	54.00	8.60	45.40	169.48
32	54.00	6.78	47.22	122.26
33	54.00	4.89	49 11	73.15
34	54.00	2.93	51.07	22.08
35	22.96	.88	22.08	00.00

Source: Federal Land Bank of New Orleans..

Table 3. Example of Amortization Table—Decreasing-Payment Plan, Principal $1,000, Interest Rate 4 Per Cent, Annual Installments, 20 Years

Installments		Interest	Payment on principal	Principal still unpaid
Number	Amount			
1	$90	$40	$50	$950
2	88	38	50	900
3	86	36	50	850
4	84	34	50	800
5	82	32	50	750
--	....	....	....	......
10	72	22	50	500
11	70	20	50	450
12	68	18	50	400
13	66	16	50	350
14	64	14	50	300
15	62	12	50	250
16	60	10	50	200
17	58	8	50	150
18	56	6	50	100
19	54	4	50	50
20	52	2	50	00

Either plan of repayment may also be used for loans with a longer or shorter term of years.

Maturity Terms and Amortization

Observation of the experiences of farmers over the past 30 years shows that normally it takes 20 or more years to pay off a real estate mortgage loan. If farm real estate loans are made to become due in three to five years, many renewals become necessary, and these are expensive for the borrower. At the time a farm mortgage loan through a national farm loan association is being considered, arrangements are made to spread the payments over a period suited to the requirements of the borrower. In Louisiana this period commonly ranges from 20 to 35 years. However, payment of the loan in full is permitted at any time without penalty. Advance partial payments are accepted also in any year when the borrower might wish to make such payments and this privilege makes it possible for the farmer to pay more than the amount due on the principal in years when incomes are above normal expectations and none at all in years when prices or yields are low.

Plans with respect to the length of the repayment period and the regular amount to be paid each year are agreed upon before the loan is closed. Some payment is made on the principal at each interest due date, and the interest stops immediately on that part of the loan that has been paid. The plan made in advance for the gradual liquidation of a real estate mortgage loan is known as amortization. In the "Even-Payment Plan" as shown in Table 2, the annual payments remain the same, while the interest grows smaller and payment on the principal grows larger as each installment is paid. In the "Decreasing Payment Plan," payments on the principal remain constant, while the interest due and the total payments decline each year (Table 3). If the regular payments are made as scheduled in either plan, the loan never has to be renewed and is liquidated with the last payment.

Table 4. Consolidated Financial Statement of the National Farm Loan Associations in Louisiana as of June 30, 1951

Assets	Amount	Liabilities	Amount
Cash on hand and in banks	$ 50,656	Capital stock outstanding	$ 816,740
Accounts receivable	822	Surplus	665,850
Investments	885,400	Legal reserve	137,920
		Accounts payable and trust accounts	68,562
Capital stock in FLB of New Orleans	816,740	Reserve for losses on endorsed loans	41,879
		Dividends	22,667
Total assets[1]	$1,753,618	Total liabilities	$1,753,618

Source: Federal Land Bank of New Orleans.

[1] In addition, the Louisiana associations have Indemnity Account Credits with the Federal Land Bank of New Orleans in the amount of $825,295. This asset is dedicated to cover losses on endorsed loans, if such losses should occur.

Financial Position of NFLA's

The assets of national farm loan associations in Louisiana in June 1951 consisted largely of investments in bonds and capital stock in the Federal Land Bank of New Orleans. The associations owned total assets in the amount of $1,753,618. It should be noted that real estate mortgage loans made through the associations are not carried by them as assets. These loans appear as assets of the Federal Land Bank of New Orleans, but all owned assets of the associations are obligations to the Federal Land Bank of New Orleans and may be used to replace any losses arising out of loans made.

The principal liabilities of the national farm loan associations consist of capital stock outstanding to farm borrowers and surplus funds built up out of income. The surplus and reserve accounts were $845,649 in June 1951.

Income and Dividends on Capital Stock

The main sources of income to the 21 national farm loan associations in Louisiana are: (1) compensation paid to them by the Federal Land Bank of New Orleans for servicing the loans made through the associations and performing other duties connected with the farm loan business; (2) dividends on stock in the Federal Land Bank of New Orleans; and (3) income from investments of reserves and surpluses.

For a number of years, the associations in Louisiana required a large part or all of their income to meet operating expenses, to pay losses, and to provide for the accumulation of an adequate reserve fund. The result of this condition was that during the 1930's the borrowers did not receive dividends on the stock owned by them in the national farm loan associations. However, the income and the financial condition of the Louisiana associations improved substantially by the early 1940's, and since 1943 all but one association has paid a dividend each year to the stockholders. The dividends have ranged from 4 to 10 per cent, but the most common rate has been 5 per cent.

Summary Statement, NFLA's

The 21 national farm loan associations in Louisiana provide farmers with an opportunity to obtain long-term credit on the amortization plan for repayment, and the rate of interest in 1952 was 4 per cent. Loans are available for the purchase of farms, the enlargement of farms, the refinancing of existing debts, the construction or repair of farm buildings, the improvement or conservation of farm land, the purchase of machinery, and any other agricultural purpose. By extending real estate loans to farmers at moderate interest rates on terms adapted to the needs and repayment capabilities of agriculture, national farm loan associations perform a valuable service in assisting farmers to gain and retain ownership of productive farm property. Farm ownership by at least 50 per cent of all farm operators is essential to the highest development of agriculture and to the welfare of the nation.

The cooperative system of farm mortgage credit which began with the passage of the Federal Farm Loan Act of 1916 is farmer owned and farmer operated. Since stock ownership by members is one of the basic cooperative features of the Land Bank System, each member of a national farm loan association is required to own stock in an amount equal to 5 per cent of the loan granted. When a farmer pays off his loan, his stock is cancelled and its value returned to him. Since 1943 all but one association has paid an annual dividend to its stockholders.

On June 30, 1951, national farm loan associations in Louisiana had 5,109 members with loans outstanding in the amount of $12,553,650. The associations furnish contact between the farmers needing credit and loan funds available for investment. It is their function to obtain farm mortgage credit service for farmers through the Federal Land Bank of New Orleans, endorse loans granted, and give authorized service to loans outstanding.

COOPERATIVE PRODUCTION CREDIT ASSOCIATIONS IN LOUISIANA

Origin and Legal Foundation

A production credit association is a cooperative organization of farmers whose purpose is to provide a permanent and dependable source of credit at reasonable cost and with terms adapted to farm conditions. It is managed by the borrowers for their mutual benefit, and its only business is to make loans to farmers and stockmen.

Production credit associations were in a real sense born out of necessity. From 1930 to 1933, prices of farm products declined severely, and closures of commercial banks were widespread. In most rural areas, the seasonal credit needed was not obtainable through banks of deposit because their assets were frozen and funds for new loans were not available. To remedy the condition and provide a permanent and dependable source for farm operating credit, the Congress passed the Farm Credit Act of 1933, which provided for the organization and capitalization of production credit associations under the supervision of a Production Credit Corporation established in each of the twelve Farm Credit Administration districts.

The production credit associations in Louisiana were organized under the terms provided in the Farm Credit Act of 1933 and are part of a national farm credit system which channels the flow of loan funds from money centers to the remotest farming community at the least cost consistent with sound finance. They are organized in such a manner as to provide a dependable source of credit in times when local loanable funds are scarce as well as when they are plentiful, and are intended to be permanent institutions.

Number, Location, and Territory Served

There are eight production credit associations in Louisiana chartered in 1934 by the governor of the Farm Credit Administration under authority of the Farm Credit Act of 1933. The name, year organized, location of the main office, and name of the active administrative officer for each of the eight associations follow:

1. Alexandria Production Credit Association, (1934), Alexandria, S. F. Trammell.
2. Arcadia Production Credit Association, (1934), Arcadia, Roy Brice.
3. Baton Rouge Production Credit Association, (1934), Baton Rouge, W. R. Anthon.
4. Jennings Production Credit Association, (1934), Jennings, L. P. Theriot, Jr.
5. Opelousas Production Credit Association, (1934), Opelousas, Clarence Harmon, Jr.
6. Shreveport Production Credit Association, (1934), Shreveport, S. T. Hamiter.
7. South Louisiana Production Credit Association, (1934), Napoleonville, R. C. Martin.
8. Tallulah Production Credit Association, (1934), Tallulah, D. M. Kell.

The territory served by each association, the location of the main offices, and the field offices are shown in Figure 2. Because of the large area served by each of the associations, field offices are maintained for the convenience of farmers located at outlying points. The eight production credit associations in Louisiana are under the general supervision of the Production Credit Corporation of New Orleans, which also has supervision of associations in Alabama and Mississippi. The three states comprise Farm Credit Administration District No. 5.

In addition to the eight cooperative production credit associations organized under the Farm Credit Act of 1933, there is a production credit association located in New Orleans and incorporated in 1926 under Louisiana law for the purpose of extending short-term loans to sugar cane planters.[1] The name of the organization is "The State Agricultural Credit Corporation, Inc." It obtains loan funds by discounting farmers' notes with the Federal Intermediate Credit Bank of New Orleans. During the period when the growing of sugar cane was in a precarious condition owing to the ravages of root rot and mosaic disease, the State Agricultural Credit Corporation, Inc. financed as much as 41 per cent of the sugar cane acreage. The corporation has enjoyed excellent management and continues to be important in financing sugar cane farmers. During 1951, it extended loans in the amount of $1,458,964. The operations of the State Agricultural Credit Corporation, Inc. are not included in the data shown in the balance of this report.

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[1] Short-term credit as used in this report includes any credit extended for a period of less than three years and not secured by a real estate mortgage. The majority of farm operating loans are made for periods of less than twelve months.

Cooperative Short-term Farm Credit Institutions, Louisiana, 1952

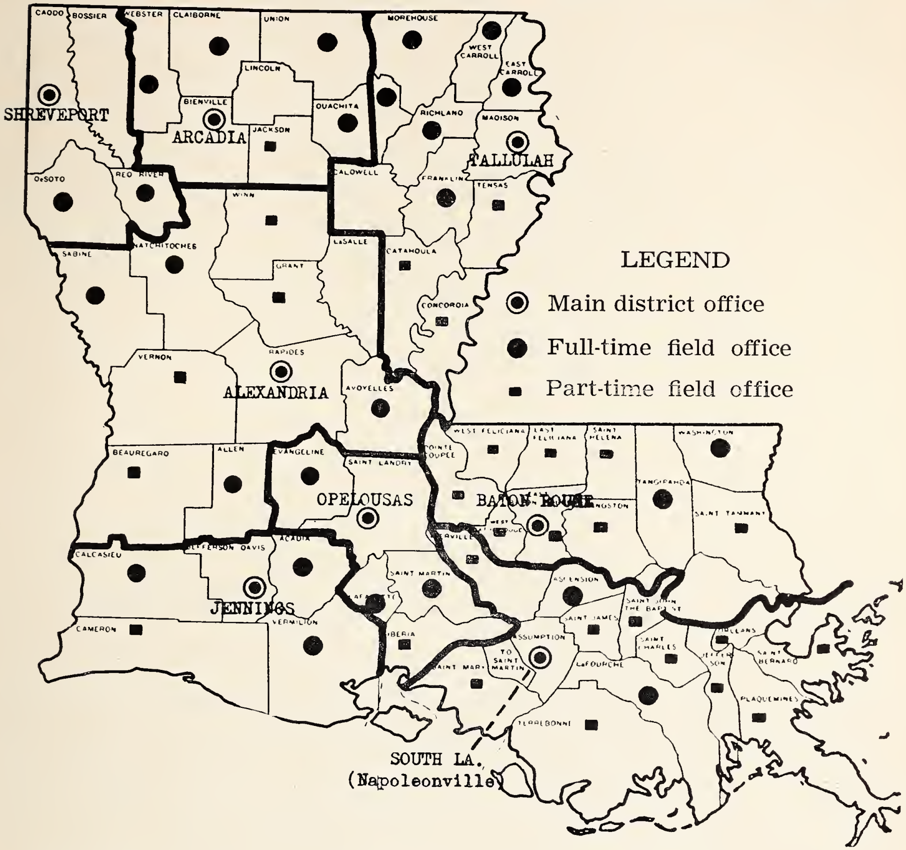

Figure 2. Eight production credit associations were chartered in Louisiana by the Governor of the Farm Credit Administration in 1934. In the beginning farm members owned only a small portion of the capital stock, but on January 1, 1952, they owned 92.5 per cent of the capital stock. In keeping with the constantly growing amount of operating capital employed on modern farms in Louisiana, the amount of loans disbursed increased from $2,350,743 in 1934 to $28,668,268 in 1951. The State Agricultural Credit Corporation, Inc. in New Orleans made loans during 1951 in the amount of $1,458,964, and this is in addition to the loans made by associations chartered by the Governor of the FCA.

Capital Stock and Reserve Accumulation

In the fall of 1933, when production credit associations were first organized, farmers did not have the cash savings required to provide the capital stock base necessary to establish the reliability of PCA's as financial institutions. In Louisiana, the original capital stock was subscribed largely by the Production Credit Corporation of New Orleans, and only

10 per cent was owned by farmers and stockmen. By 1951 the Federal funds had been largely repaid, and the farmers owned 92.5 per cent of the capital stock. A consolidated statement of the associations in Louisiana as of December 31, 1951, shows total paid-in capital of $2,074,585, of which all but $155,000 was owned by Louisiana farmers (Table 5).

Table 5. Paid in Capital Stock and Number of Stockholders for Eight Production Credit Associations in Louisiana as of December 31 for Years Shown

Year	Paid-in capital as of December 31				Number of stockholders	
	Total	Class A stock owned by PCC	Capital stock owned by farmers and stockmen		Class B	Class A other than PCC
			Class A	Class B		
	Dollars				Number	
1935	2,034,385	1,832,000	....	202,385	5,932	.. ..
1937	2,067,955	1,743,000	8,985	315,970	6,366	818
1939	2,058,855	1,686,000	21,425	351,430	6,978	765
1941	1,983,780	1,543,000	25,850	414,930	6,719	117
1943	2,136,615	1,543,000	36,485	557,130	7,587	1,672
1945	1,760,555	1,050,000	53,735	656,820	8,363	2,261
1947	1,743,510	825,000	99,395	819,115	8,648	3,355
1949	1,993,400	525,000	294,640	1,173,760	9,577	4,487
1950	1,794,090	280,000	309,230	1,204,860	9,595	4,978
1951	2,074,585	155,000	318,835	1,600,750	9,150	5,251

Source: Production Credit Corporation of New Orleans.

Since the capital supplied by the government in purchasing stock in production credit associations has in large part been returned, the income received from the Federal funds before repayment constitutes the principal monetary contribution of taxpayers to the building of a dependable and sound short-term credit system for farmers. The capital invested by the government in the capital stock of PCA's during their infancy provided them with financial reliability and enabled them to discount farm paper at low rates of interest with the Federal Intermediate Credit Bank of New Orleans. On January 1, 1952, the associations in Louisiana had reserves from earnings in the amount of $2,373,699. The rate at which reserves have been accumulated is due in part to the interest received on capital furnished by the Federal government during the formative years.

The sizable amount of reserves and capital stock owned by the PCA's provides them with an excellent credit rating. The law under which production credit associations are chartered requires the accumulation of adequate reserves and stipulates that earnings must be used: first, to pay operating expenses; second, to replace losses incurred, if any; third, to restore any impairment of capital; fourth, to create reserves for bad and doubtful loans; and fifth, to create a guaranty fund equal to at least 25 per cent of the association's paid-in capital. After the foregoing requirements have been satisfied, any balance remaining may be paid as dividends not exceeding 7 per cent. The accumulation of adequate reserves protects the investment of members in the capital stock of the association and gives it the financial strength necessary to survive periods of adversity and to continue to make new loans when economic conditions are not favorable.

Source of PCA Loan Funds

Since PCA's do not accept deposits or loan government money, and must function in "bad" as well as in "good" times, they cannot depend upon local cash savings as a source for loan funds. The bulk of the loanable funds for PCA's in Louisiana are obtained from the Federal Intermediate Credit Bank of New Orleans. After an association has made a loan, it ordinarily submits the member's endorsed note and related loan papers to the FICB. If the loan is acceptable, the FICB buys the loan with recourse, and remits to the association the amount that has been disbursed. Loans not acceptable to the FICB may be carried by the association in so far as it has loanable funds of its own.

The Federal Intermediate Credit Bank replenishes its lending funds from time to time through the sales of short-term securities (debentures) to the investing public. The debentures are secured by agricultural loans, cash or United States Government bonds, having a face value equal to the debentures outstanding. The collateral securities for debentures are deposited with the Farm Loan Registrar, who is a bonded public official appointed by the Farm Credit Administration. The debentures are the joint obligations of the twelve Federal intermediate credit banks, but are not guaranteed by the United States Government. In the money markets, the short-term securities of the FICB's are classed as "prime paper" and sell for low rates of discount.

Growth in Volume and Size of Loans

The total amount of loans disbursed to farmers by PCA's during 1951 was $28,668,268, and the number of loans made was 8,686 (Table 6). The average loan was $3,300; the smallest loan made was $50 and the largest $150,000. With only minor exceptions, the amount of loans disbursed has increased each year since 1934. Between 1940 and 1951 the volume of loans increased fourfold. Part of the increase is due to new business, but to a considerable extent the increased volume of loans is due to the reduced value of the dollar and an increase in the amount of operating capital used on Louisiana farms. Reference to column 4 in Table 6 shows that the average size of loan was $604 in 1935, $991 in 1940, $1,750 in 1946, and $3,300 in 1951.

Traditionally, the volume of operating loans outstanding on December 31 was small, since crops were generally marketed by farmers before the end of the year. Reference to the last column in Table 6 shows a marked upward trend in amount of loans outstanding as of December 31. The amount of loans outstanding at the end of 1935 was $390,394 as compared with $9,833,501 in 1951. The reason for the sizable in-

Table 6. Number of Loans Closed and Amount of Loans Disbursed During the Year and Amount of Loans Outstanding at the End of the Year, Eight Production Credit Associations in Louisiana, 1934-1951

Calendar year	Number of loans closed	Amount of loans disbursed	Amount per loan	Loans outstanding
	Number	Dollars	Dollars	Dollars
1934	3,972	2,350,743	592	280,420
1935	5,821	3,517,985	604	390,394
1936	5,675	4,237,041	747	789,443
1937	6,689	5,835,725	872	1,483,143
1938	7,047	6,200,894	880	1,550,848
1939	6,643	5,970,825	899	1,661,780
1940	6,423	6,365,689	991	2,389,252
1941	6,637	7,868,102	1,185	2,620,263
1942	6,620	9,340,404	1,411	2,149,219
1943	6,570	9,300,653	1,416	2,135,715
1944	6,745	9,848,924	1,460	2,342,815
1945	6,514	10,648,548	1,634	2,787,116
1946	7,241	12,673,720	1,750	3,608,654
1947	7,252	14,463,340	1,994	3,719,068
1948	7,881	18,130,459	2,301	5,733,979
1949	8,165	19,666,299	2,409	5,156,526
1950	8,901	21,763,161	2,445	6,278,272
1951	8,686	28,668,268	3,300	9,833,501

Source: Production Credit Corporation of New Orleans.

crease in amount of loans outstanding in December is that the proportion of operating capital loans made to purchase dairy cows, beef cattle, tractors, durable farm equipment and for the orderly marketing of staple farm products stored in bonded warehouses has increased markedly since 1935. If satisfactory progress has been made, loans for the purpose of acquiring durable operating capital are renewable and may be gradually liquidated over a period of time. Loans secured by bonded warehouse receipts for rice and cotton are made during the harvest season and in large part liquidated during the spring months.

Purpose of Loans and Nature of Security

Farm owners and tenants can obtain loans from a production credit association for all types of farm operations, provided they qualify as sound credit risks. In Louisiana, the principal items financed are the planting, harvesting, and marketing of cotton, rice, sugar cane, sweet potatoes, and other vegetables; the breeding, raising, and feeding of dairy cattle, beef cattle, and poultry; the purchase and repair of tractors and other farm machinery; refinancing of short-term debts; and for necessary consumption goods for the farm family.

Most loans are secured by a first lien chattel mortgage on crops, livestock, and machinery. In some cases, members who have established a reputation for promptness and dependability may obtain credit on an unsecured note. In general, the security required varies with the degree of risk involved. In all cases, the associations try to avoid loans in excess of the capacity of business itself to repay out of anticipated income, since the object is to help farmers to make financial progress, and this goal would not be served by over-loaning in relation to prospective returns.

In order to be approved for credit, the applicant must own at least some of the operating equipment and livestock necessary to carry on the type of farm production in which he is engaged; possess the ability to manage his farm with reasonable efficiency; and be known as an honorable man in the conduct of his financial affairs. If the amount of loan requested can be liquidated in an orderly manner by the sale of the commodities on which the loan is based, and sufficient security is available, the application will be approved by the loan committee. The chattels offered as security for a loan are checked by competent representatives of the association before the application is acted upon by the loan committee.

For borrowers who have established a reputation for honesty and dependability through previous loans, a loan may be obtained in a few hours, and in any case a loan application will be approved or rejected within a week. Since interest will be paid only for the actual time the borrowed funds are used, and since credit can be arranged for an entire season and the funds withdrawn at the times when they are needed, it is good business for the farmer to make his credit arrangements during the month when timely work on the farm is least urgent.

Loan Maturities

All loans made through production credit associations mature in one year or less. This statement needs further clarification in order to avoid unwarranted implications. Loans made to purchase items that largely disappear in the productive process, should, of course, be paid out of the receipts from sale of the product produced. Seed, fertilizer, feed, oil, gasoline, and twine are examples of goods used only once.

Loans are needed also to buy durable capital goods such as tractors and tractor equipment, dairy cows, etc., the productive life of which extends over several years. There are two reasons why loans obtained to purchase such durable production goods are made with a maximum maturity of one year. First, the Federal Intermediate Bank debentures have a maturity of one year or less, and consequently the pledged securities must be of a similar nature. Normally, debentures based on longer time securities command a higher rate of discount. Secondly, experience shows that the loss ratio is reduced, if the movable securities for short-term loans are checked at least once each year. If it is found that the chattels are being improperly handled or dissipated, the PCA is in position to call the loan at the end of the year and thus reduce prospective losses.

Although for the reasons stated, loans to purchase durable production goods are made to mature in one year, there is a verbal understand-ing that such loans will be renewed, if inspection shows proper care of the security and a reasonable increase in equity on the part of the borrower. Dependable farmers who need extra time may be given up to three years to liquidate loans to purchase livestock and durable machines.

The Rate of Interest Paid by Farmers

The rate of interest in the first half of 1952 on production credit association loans in Louisiana was 5.75 per cent as compared with 5 per cent in 1950. The higher rate in 1952 reflects the higher rate required to market the debentures of the FICB. The rate paid by the farmer borrower is the discount rate of the FICB (2¾ per cent in May 1952) plus the margin taken by the association to pay operating expenses and to accumulate reserves as a cushion against possible losses. The margin fixed by each PCA may vary from 3 to 4 per cent with the approval of the Production Credit Corporation. The PCA cannot take a margin of less than 3 per cent or over 4 per cent without the approval of the Production Credit Commissioner in Washington.

Budgeted Loans Save Interest Cost

A farmer can reduce the cost of interest on a given amount of credit by making use of the "budgeted loan." This means that the member arranges with his PCA for the amount of money needed during the following season to be disbursed to him as needed. An illustration of what is meant by a "budgeted loan" and how it reduces the amount of interest paid as compared with a regular loan is given in Table 7. The interest charge is computed on the basis of the actual number of days each dollar is outstanding, and in the illustration given, amounts to $25.96 as compared with $41.67 if interest at 5 per cent were paid on the full amount of the loan from the first day part of the loan is used until the last dollar is repaid. The higher the rate of interest, the greater the savings resulting from a budgeted loan.

A budgeted loan not only reduces interest expense, but it also serves the borrower in several other ways. It assures him that the funds will be available as needed to meet necessary expenses; it saves time during his busy season; the analysis of his credit requirements and ability to repay at the time of arranging for a loan helps to prevent the excessive use of credit; and it provides for an orderly retirement of the loan as farm products are marketed.

Fees and Other Loan Costs

Short-term loans are more expensive to make in comparison to interest returns than are farm mortgage loans, since the latter are usually outstanding for a number of years. In order to cover costs of reviewing the borrower's farming operations, searching the records for prior liens, drawing the legal papers and notarizing them, the associations have found it necessary to charge a service fee. These service fees vary among associations, but the most common fee for loans of $200 or less is $2.50.

Table 7. Illustration of How a Budgeted Loan Saves Interest Cost

Date	Purpose of advance		Amount of advance	Source of repayment	Amount repaid	Balance outstanding	Days outstanding	Interest at 5 per cent
January 1	Seed	$100						
	Fertilizer	100	$200	—	—	$200	31	$0.85
February 1	Fencing	100						
	Labor	125	225	—	—	425	28	1.63
March 1	Doctor bill	75						
	Repairs	50	125	—	—	550	31	2.33
April 1	Labor		115	—	—	665	30	2.73
May 1	Cow		100	—	—	765	31	3.25
June 1	Labor		50	—	—	815	30	3.35
	Cotton sacks and Misc.		75	—	—	890	31	3.78
August 1	Repairs		110	—	—	1000	31	4.24
September 1	—		—	8 calves	$240	760	30	3.12
October 1	—		—	4 bales cotton	600	160	31	0.68
November 1	—		—	4 hogs	160	—	—	—

Total amount loaned—–$1000

Total interest to PCA	$25.96
Loan service fee to PCA	11.00
Recording fee	.75
Total cost of loan	$37.71

NOTE: The interest on an ordinary loan for $1000 made on January 1 and repaid on November 1 at 5 per cent would be $41.67.

Source: Louisiana Rural Economist, Vol. 10, No. 3, August 1948, page 2.

On loans from $201 to $1,500, it is one per cent; and on loans from $1,501 and up, the average service fee is $16 plus one-fourth of one per cent on the amount above $1,500.

It is the policy of each association in Louisiana to reduce loan fees as rapidly as the interest income from loans and from owned assets is sufficient to adequately support the organization. One association in 1952 did not charge a fee on loans under $500, reduced the fees on loans of $500 to $1,000, and hopes shortly to abolish all fees on loans under $2,000. While it will be many years before associations having a comparatively small volume of loans can operate without loan fees, those with a sizable volume of loans will soon abolish loan fees on loans under $2,000, if not altogether. The impact of loan fees on large loans is insignificant. Since the associations were not organized for the purposes of making maximum returns on their invested capital, the reduction of loan costs becomes a desirable policy as soon as income grows larger than the amount needed for operating costs, the accumulation of adequate reserves, and a 5 per cent annual dividend on capital stock.

The recording fee for a chattel mortgage in Louisiana is commonly seventy-five cents and the same for a crop lien. When the production credit associations were first organized, the recording fees were much higher than they have been in recent years. At present a copy of the chattel mortgage and the crop lien are filed, and this eliminates the labor formerly required to copy the instrument in the office of the clerk of court, and thereby, real costs are reduced.

Summary Statement on PCA's

The record of the production credit associations indicates that the principles followed in their operation are sound from a financial standpoint and that they have made a real contribution to development and progress of farm families in Louisiana. The ability of Louisiana farmers with consultant help from the Production Credit Corporation of New Orleans to operate a cooperative production credit system in a manner suited to the particular requirements of farming has been demonstrated. It includes the utilization of the facilities of the intermediate credit banks for tapping primary money sources whose dependability is not affected by local or regional economic conditions unfavorable to agriculture. The associations have been instrumental in improving the terms of operating loans and in reducing the cost of short-term credit. The importance of having a source of credit that will function in "hard times" as well as in "good times" cannot be overestimated.

BANK FOR COOPERATIVES

One of the major problems facing a group of farmers desiring to organize and operate a cooperative association is the procurement of adequate funds with which to acquire buildings, machinery, and equipment, and to perform the daily business activities of the association. This is particularly true when the cooperative is one whose function involves the physical handling, storage, or processing of agricultural products through the facilities of expensive buildings and machinery. Under ordinary circumstances, members are able to raise enough money to finance bargaining and marketing associations, or even certain types of processing establishments where the cost of providing necessary facilities is small, but in cases where a large investment in fixed assets is required, as with sugar mills, rice driers, and storage bins, or cotton gins, the members must turn to some outside source of credit to assist in meeting the capital requirements of the association.

The need for credit by farmer cooperatives is indicated by an examination of the collective balance sheet for Louisiana cooperatives in 1950. With the exclusion of electric power associations financed through the Rural Electrification Administration, the total liabilities of the 103 local and state-wide organizations amounted to $23,707,971 or 71 per cent of the total investment in the associations. On January 1, 1952, the New Orleans Bank for Cooperatives had loans outstanding in Louisiana to 34 associations in the amount of $4,924,106. During 1951, one association completed the repayment of its loan, and four associations were added to the list of borrowers (Table 8).

Table 8. New Orleans Bank for Cooperatives Loan Activity in Louisiana

Year	Loans outstanding at close of year				Number of cooperative associations		
	Facility	Operating capital	Commodity	Total	With loans outstanding close of year	Added during year	Paid out during year
	Dollars	Dollars	Dollars	Dollars			
1951	3,206,317	1,717,789	none	4,924,106	34	4	1
1950	2,528,247	5,892,131	none	8,420,378	31	8	5
1949	2,537,696	8,308,415	none	10,846,111	28	2	5
1948	2,736,802	7,267,757	93,164	10,097,723	31	5	3
1947	2,683,317	6,141,616	none	8,824,933	29	7	4
1946	1,654,167	5,702,085	100,149	7,456,401	26	7	2
1945	1,025,952	3,649,573	495,060	5,170,585	21	3	6
1940	1,710,372	487,701	none	2,198,073	12		
1935				618,395	12		

Source: New Orleans Bank for Cooperatives.

Development of Credit for Cooperatives

Prior to World War I, the principal sources of investment and working capital for cooperatives were individuals, commercial banks, and members of the cooperatives themselves. Usually, members were not financially able to furnish all the necessary capital, and banks were frequently unwilling to make loans to the cooperative type of enterprise. Commercial banks were inclined to look upon farmer cooperative organizations as having the same risk and uncertainty hazard with respect to stability of income as farm incomes which are affected by variable crop yields and by instability of farm prices. As a result, loans to cooperatives, when obtainable, were characterized by terms not suited to orderly marketing and by high interest rates. The first public funds made available as loans to farmer cooperatives were secured through the War Finance Corporation shortly after World War I. The Agricultural Credit Act of 1923 authorized the Federal intermediate credit banks to make loans to farmer cooperatives, and these institutions performed an important function in this connection.

The first "bank" for cooperatives, set up by the Agricultural Marketing Act of 1929, provided for a revolving loan fund of 500 million dollars to be administered by the Federal Farm Board. The Farm Credit Act of 1933 created the Farm Credit Administration and, among other things, provided special banks to extend credit to farmer cooperative organizations. In addition to the Central Bank for Cooperatives, located in Washington, D.C., twelve district banks were established. The original capital stock for each district bank was 5 million dollars and was subscribed by the United States Government. Loan funds for district banks are obtained from two main sources: first, paid in capital, surplus, and savings; and secondly, loans from or discounts with the Central Bank for Cooperatives, and to a smaller extent, from discounts with the Federal intermediate credit banks and loans from commercial banks.

Purposes and Types of Loans

Cooperative associations borrow funds from a bank for cooperatives for three purposes: (1) to acquire land, buildings, and equipment used in the business activities of the association; (2) to obtain working capital for a particular season's operation; and (3) to obtain liquidity of exchange on commodities held by the association in the process of orderly marketing. The three types of loans are called facility loans, operating capital loans, and commodity loans. The rates of interest, respectively, were 4, 3¼, and 2¾ per cent in May 1952.

Facility loans may be used by the cooperative to finance or refinance the acquisition of fixed capital assets for the association. Land, buildings, and large items of equipment require large initial investment, and the loans for such investment have to be repaid from the earnings of the business facilitated by these assets. Facility loans may be made for a term of 20 years, but generally they are made to mature within 10 years. The size of the loan is limited to 60 per cent of the appraised value of the collateral offered, and the security generally consists of a first lien on the property itself with such additional collateral as may be required.

Operating capital loans are obtained by cooperatives to meet day to day expenses of the association. This type of loan is frequently used to supplement the cooperative's cash assets during periods of peak activity. Operating capital loans are generally short-term loans and, as a rule, are repaid by the end of the operating season. Size limitations of these loans are based on sound credit considerations and financial conditions, management, and ability to pay. There are no specific legal requirements as to the collateral which must be given to obtain operating capital loans, but the association is required usually to give liens on real estate, equipment, and supplies.

The most common use of commodity loans is to enable the cooperative association to make advances to grower members on commodities delivered to the association to be marketed in an orderly manner. Also, purchasing associations may use commodity loans to finance the purchase of adequate seasonal inventories of farm supplies. A first lien on the commodities themselves is given by the association as collateral security for commodity loans. A commodity loan cannot exceed 65 per cent of the value of the commodity unless the sale price of the commodity has been fixed, in which event the loan may equal 85 per cent of the value of the commodity. The terms of commodity loans are for periods required for normal seasonal operations, usually three to nine months.

A cooperative association borrowing from a bank for cooperatives is required to have an investment in the capital stock of the bank. The amount of capital interest which the borrowing association must have is approximately 5 per cent in the case of facility and operating capital loans, and approximately 1 per cent of commodity loans. Upon repayment in full of a loan, the association's capital interest in the bank acquired in connection with the loan is retired unless the association desires to continue its ownership interest.

Loan Requirements and Costs

Before an association can be granted a loan from a bank for cooperatives, certain information is required concerning the nature and characteristics of the association. Briefly, this information pertains to: (1) evidence of the economic need for a cooperative; (2) existence of sufficient volume of business to assure successful operation; (3) quality of membership (stability, leadership, cohesion, etc.) ; (4) market outlets or sources; (5) facilities needed, if any, and costs; (6) capital requirements and source of capital, including amount contributed by members; (7) determination that the association is a legal cooperative and that its organizational papers will permit the operation on a sound cooperative basis; and (8) satisfactory management.

The initial cost of obtaining a loan from a bank for cooperatives varies with the type of loan and with the conditions under which it is made. A cooperative association has very little expense in obtaining a loan if the organizational papers of the association are in order and clear titles have been established on property owned by the cooperative. In the matter of facility loans, it is sometimes necessary to obtain the services of an outside appraiser, and when this is done, the borrowing association employs the appraiser and pays his fee.

Summary Statement

Banks for cooperatives are not authorized to lend money to individual farmers but do provide a source of credit to groups of farmers organized in a cooperative effort to store, process, and market their products or obtain supplies used in farm production at lower costs. Loans are designated by the use made of the funds and are called facility, operating capital, and commodity loans. Rates of interest on the three types of loans in May 1952 were respectively: 4, 3¼, and 2¾ per cent.

The Farm Credit Act of 1933 provided for 12 regional banks for cooperatives located in each of the 12 Farm Credit districts in the United States. The New Orleans Bank for Cooperatives serves Alabama, Mississippi, and Louisiana. On January 1, 1952, the New Orleans bank had loans outstanding to 34 cooperative associations in Louisiana in the amount of $4,924,106.

COMMENTS ON THE USE OF CREDIT

The risk involved in using credit is greater in times when prices of land and durable production goods are high and when used in enterprises where the amount of product that will be produced in a particular year is more uncertain than the price. Some people who have experienced or have observed the tragedy of excessive debt and foreclosure, question the wisdom of farmers using credit in order to gain ownership control over land and the economic goods necessary for operation. The alternative for most farmers would be to save until they could purchase with their own cash, and in the meantime rent the land and the operating capital needed. While there are risks involved in the employment of credit, the consequences of not having dependable and adequate sources of commercial credit available to farmers would be intolerable in modern farming. Credit prudently employed has enabled farmers to reduce costs, conserve land and improvements, and to raise the living standard enjoyed by their families.

The practical and important consideration for most farmers is how to reduce the risks of loss to a minimum. The risk of loss will be reduced if the purposes for which a loan is contemplated and the probable ability to repay are carefully considered before the loan is consummated. It is essential that credit obligations for business purposes be assumed only after careful analysis leads to a judgment that the use of borrowed capital will increase the borrower's income more than it increases costs. When capital goods are borrowed for productive purposes, the main source of funds for repayment should be out of income from the enterprises financed.

While a prudent individual will invest his own savings as thoughtfully as he would borrowed funds, a loss of capital accumulated out of past income or inheritance is less severe in its effects on the individual family, since it does not have to be recovered out of savings from future income. If there were no risks in farm production, competition in the produce markets would be increased greatly. Unfavorable weather which results in low yields and other hazards such as price changes and sickness, often result in inability to meet in full credit obligations incurred for the production of a given crop. For these reasons, the general principle of not borrowing more than about one-half of the anticipated income from a given crop enterprise is sound from the standpoint of the farmer interested in managing his financial affairs in a prudent manner.

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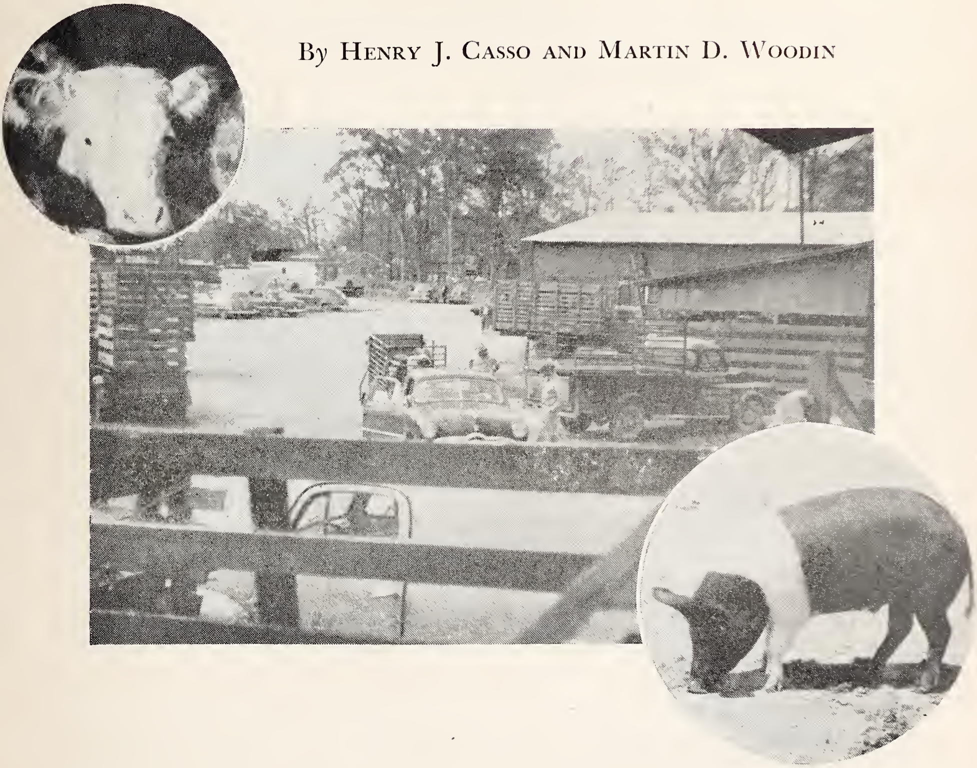
Marketing Practices of Livestock Producers

in Louisiana

By Henry J. Casso and Martin D. Woodin



Louisiana State University and Agricultural and Mechanical College

Agricultural Experiment Station W. G. Taggart, *Director*

Louisiana Bulletin No. 471 **March 1953**

SUMMARY

About two-thirds of the commercial and part-time farms in the state produce livestock for sale. Receipts from sales of cattle, calves, hogs, and sheep comprise about a fifth of total cash income from farm marketings, and in 1951 amounted to $70 million.

The number of cattle and calves on farms has increased 80 per cent in the last twenty years and on January 1, 1953 totaled 1,771,000 head. Although both hog and sheep numbers have declined, there were on farms 463,000 hogs and 122,000 sheep as of January 1, 1953.

The nature of the beef cattle industry in Louisiana is indicated by the nature of farm sales. About two-thirds of the livestock sold are under one year of age, and about one-fourth over two years of age. Slaughter cattle and calves make up two-thirds of producers' sales and stockers about one-fifth. Since slaughter calves comprise such a large proportion of sales, the average weight for all cattle is relatively low, about 480 pounds. Normally, sales are highest in the fall and lowest in the late winter and early spring.

Nearly three-fourths of producers' sales are made through auctions. Terminal markets, dealers and trucker-buyers, other producers, and packing plants follow in that order as additional outlets.

To a majority of producers the system of auction selling is an improvement over previous methods of marketing. This is particularly so for smaller producers. Auctions provide a year-round market for all classes of animals, sales are for cash, the producer can see his animals sold, weighing facilities are available, and the producer usually feels that his livestock is sold under conditions of competitive bidding among buyers.

While the present marketing system is generally satisfactory, some complaints are expressed by both buyers and sellers. These largely relate to (1) selling charges, (2) market information, (3) spread of diseases, (4) small size of some auctions, (5) time required to conduct sales, (6) injuries to livestock, (7) uncertainty of quality, and (8) other operating practices of some auctions.

The steady growth of the livestock industry in Louisiana and the South increases the importance of marketing and emphasizes the desirability of having a system which is efficient and will provide a fair return to both producers and marketing agencies. This study and others that will follow are designed to provide information which will help in accomplishing further improvements in the livestock marketing system.

Marketing Practices of Livestock Producers in Louisiana[1]

By

HENRY J. CASSO AND MARTIN D. WOODIN

Importance of Livestock Industry Increasing

The livestock industry has become increasingly important in the agricultural economy of Louisiana. Receipts from sales of cattle, calves, hogs, and sheep by farmers comprise about a fifth of total cash income from marketings, and in 1951 amounted to $70 million. Receipts from sales of dairy and other livestock products also have shown marked increases as a result of the greater production and favorable prices of recent years.

The number of cattle and calves on farms has increased 80 per cent in the last twenty years and on January 1, 1953 totaled 1,771,000 head. Although both hog and sheep numbers have declined, there were on farms 463,000 hogs and 122,000 sheep on January 1, 1953.

More Livestock Increases Need for Efficient Marketing

The greater dependence of farmers on income from livestock sales increases the need for improved livestock marketing methods and facilities. This study, therefore, was undertaken to provide information on livestock marketing in Louisiana as an aid toward the development of a more efficient system. Data for the study were obtained by personal interview from 300 producers in 24 parishes throughout the state. Objectives of this phase of the project were to determine: (1) the present methods and practices used by producers; (2) the types of markets used and their relative importance; (3) the kinds, ages, weights, and qualities of livestock sold. This information gives a true picture of what producers are doing now and serves as a basis for looking ahead to where the industry is going. It provides a better basis for determining what changes in marketing are needed and how they can be accomplished.

Other phases of the study are planned which will cover the entire livestock industry, including local markets, movement of livestock, slaughter, and the retailing and consumption of meats. Emphasis will be placed on improved practices, costs, price relationships, and an analysis of supply and demand factors.

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[1] The Department of Agricultural Economics of the Louisiana Agricultural Experiment Station is cooperating with nine other Southern States and the United States Department of Agriculture in a study of livestock marketing in the South. This report presents the results of the first phase of the study in Louisiana.

Distribution of Livestock in Areas of State

Approximately 1,300,000 cattle and calves, 625,000 hogs and pigs, and 87,000 sheep and lambs were reported on farms in Louisiana by the 1950 Census (Table 1). The Gulf area had about 40 per cent of the cattle and calves and 25 per cent of the hogs and pigs (Figures 1 and 2).[2] The Delta and Silt Loam area had about 35 per cent of the cattle and calves and 45 per cent of the hogs and pigs. About 25 per cent of the cattle and calves in the state and 30 per cent of the hogs and pigs were in the Coastal Plains area of North Louisiana. Most of the sheep are in the western parishes, mainly Beauregard (Figure 3).

Table 1. Number and Per Cent of Livestock on Farms, by Area, Louisiana, 1950*

Area	Cattle and calves		Hogs and pigs		Sheep and lambs	
	Number	Per cent	Number	Per cent	Number	Per cent
Delta and Silt Loam	447,717	35	280,789	45	12,773	14
Coastal Plains	324,920	25	189,107	30	6,645	8
Gulf	512,669	40	155,443	25	67,835	78
State 1950	1,285,306	100	625,339	100	87,253	100
State 1951	1,426,000	------	619,000	......	104,000	-----
State 1952	1,540,000	------	551,000	-----..	109,000	......
State 1953	1,771,000	------	463,000	------	122,000	------

Source: Preliminary report of the 1950 Census of Agriculture and releases of Louisiana Crop Reporting Service.

*The Census reports the number of animals on hand January 1. Ordinarily the number at this time of year is seasonally low because fall and early winter marketings have been completed and the spring calf crop has not been dropped.

Two-Thirds of Farms Sell Livestock

There were 89,300 commercial and part-time farms in 1950, of which two of every three sold some type of livestock, i.e., cattle, calves, hogs, or sheep, during the previous year. One of every two farms sold cattle and/or calves; one of every three farms sold hogs; but only one of every 100 farms sold sheep or lambs (Table 2).

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[2] Since this study is part of a livestock marketing study in the entire Southern Region, sampling procedure was designed to represent the different areas in the region. The three areas of which Louisiana is a part, designated as the Gulf, Delta and Silt Loam, and Coastal Plains areas, are so generalized as to topography, soils, types of farming, and other characteristics that they do not accurately represent the fairly distinct areas of the state. For example, the Red River delta is combined largely with the Coastal Plains area of North Louisiana. The area boundaries in the regional study do not follow parish lines, but have been redrawn to do so in this report because some livestock data are on a parish basis. In general, the Gulf area includes those parishes in the coastal prairie extending across the entire southern portion of the state; the Delta and Silt Loam area comprises the Mississippi River delta section and the adjacent terrace extending from the Arkansas border to the coastal prairie; the Coastal Plains includes mainly the North Louisiana hill parishes extending to the western boundary of the state and south to Beauregard Parish (see Figure 1).

Table 2. Proportion of Louisiana Farms Selling Livestock, 1950

Area	Proportion of farms selling: Some type of livestock	Cattle and calves	Hogs and pigs	Sheep and lambs
	(Per cent)			
Delta and Silt Loam	56	41	37	*
Coastal Plains	70	55	40	*
Gulf	74	62	32	3
State	65	50	36	1

Source: Preliminary report of the 1950 Census of Agriculture.
*Less than 1 per cent.

In the Delta and Silt Loam area there were 41,200 farms, or about 46 per cent of the total number in the state. Of these, 40 per cent, or two of every five, reported selling either cattle or calves; 37 per cent, or one of every three, reported selling hogs; and one of every 200 sold sheep.

The Gulf area had 25,100 farms, of which three of every five sold cattle or calves; one of every three sold hogs; and one of every thirty sold sheep.

More than three-fourths of the 23,000 farms in the Coastal Plains area reported livestock sales in 1949. One of every two sold cattle or calves; two of every five sold hogs; and approximately one out of every 200 sold sheep.

Number of Livestock Sold

According to the 1950 Census, Louisiana farms sold 365,635 cattle and calves, 335,191 hogs, and 30,745 sheep during 1949. There are indications that these figures understate the actual number of animals sold. Sales of cattle and calves through auction markets only during the 12-month period October 1950 to September 1951 totaled 551,700.[3] The survey of producers throughout the state showed that 71 per cent of the cattle and calves marketed by them were sold through auctions.

Number Sold Per Farm

Of those farms selling cattle during 1950, an average of 7 head per farm was sold. Average sales of calves by farms reporting calf sales were 6, of hogs 10, and of sheep 32 (Table 3). Sales of cattle per farm were highest in the Delta and Silt Loam area, and sales of calves highest in the Gulf area. Sheep sales varied most, from 21 per farm selling sheep in the Delta and Silt Loam area to 36 per farm in the Gulf area.

In general, each area of the state has a relatively small number of

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[3] Data from Louisiana Brand Commission. Sales for the period October 1951-September 1952 were 582,485.

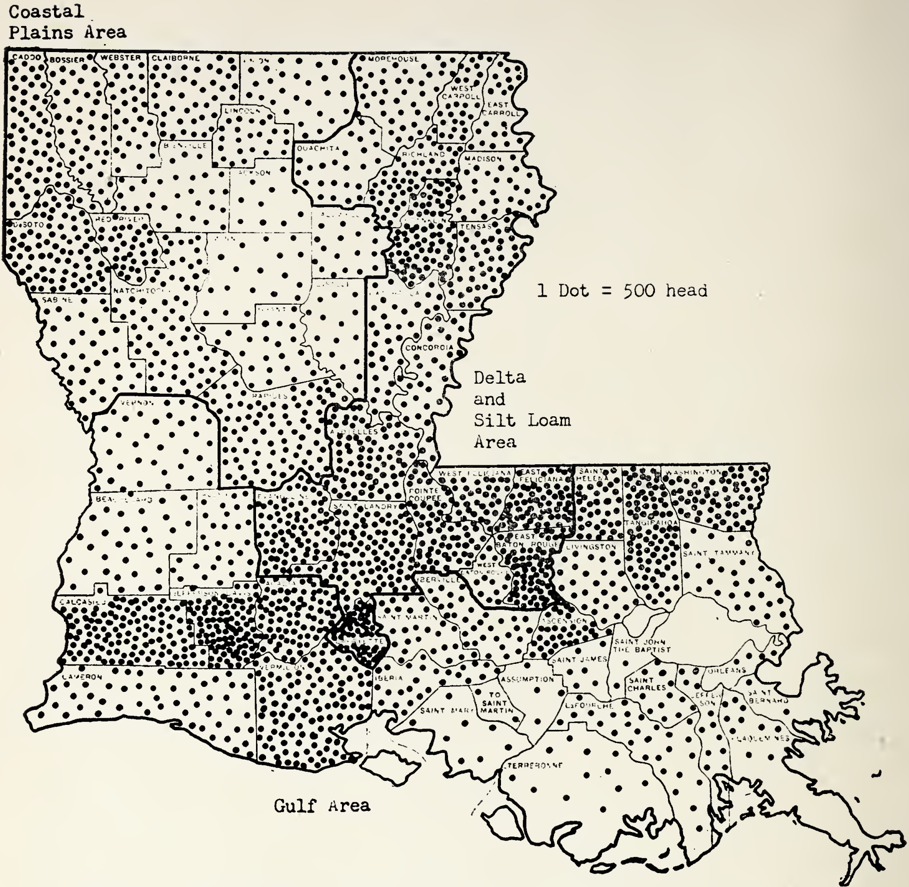

Figure 1. Distribution of Cattle and Calves in Louisiana, by Area, 1950

large producers and a large number of small producers. For example, about two-thirds of the farmers selling cattle and calves sold fewer than six animals per sale (Figure 4). On the other hand, the third of the producers who averaged six or more animals per sale accounted for nearly two-thirds of the cattle and calves sold. A large number of small producers increases the magnitude of the marketing job by increasing the transportation problem, making standardization of classes and grades of livestock more difficult, and in some instances slowing up the selling process. Under such conditions the need for the successful dissemination of market news and information is increased, but the job becomes more complex.

Seasonality of Sales

The predominant practice in Louisiana of producing calves and yearlings for sale results in considerable variation in the receipts at local markets from season to season. Normally, the number of animals

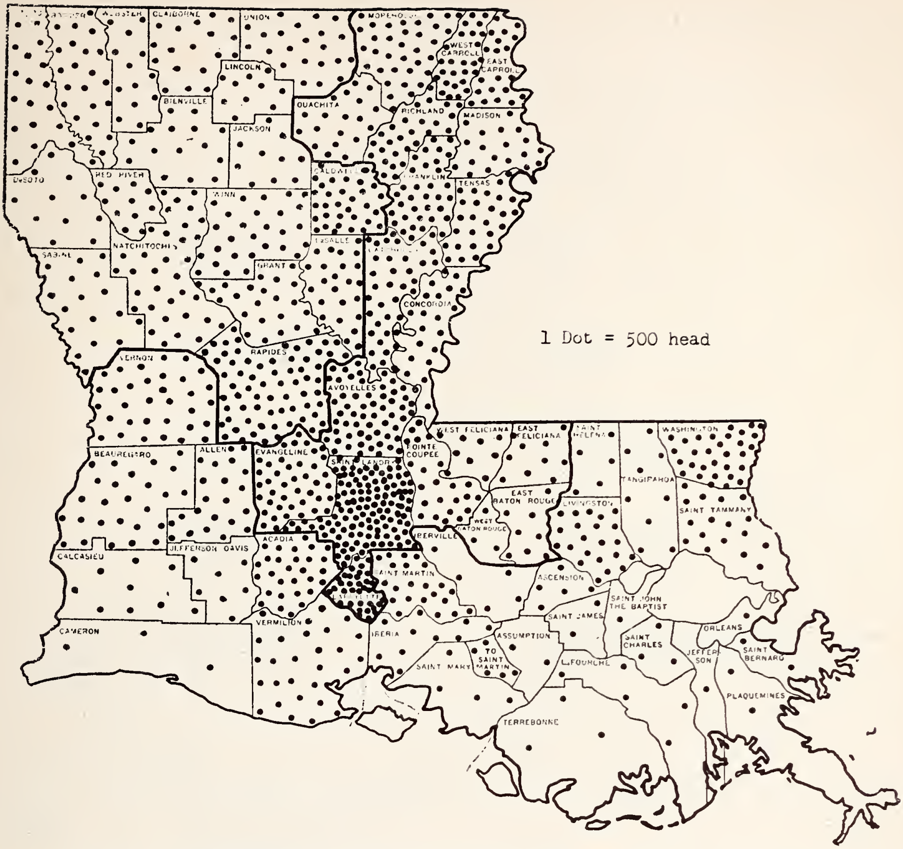

Figure 2. Distribution of Hogs and Pigs in Louisiana, by Area, 1950

marketed is highest in the fall months, September through November, when a large part of the spring calf crop is sold. Sales are usually lowest in late winter and early spring when feed is scarce and cattle in relatively poor condition. During 1951 cattle and calf sales through auctions in the state ranged from 29,000 in February to 94,000 in October (Figure 5). Variations in marketings from year to year result from differences in

Table 3. Average Number of Animals Sold per Farm in Louisiana, 1950

Area	Number per farm selling			
	Cattle	Calves	Hogs	Sheep
		(Number)		
Delta and Silt Loam	8	6	11	21
Coastal Plains	6	5	11	28
Gulf	7	8	9	36
State	7	6	10	32

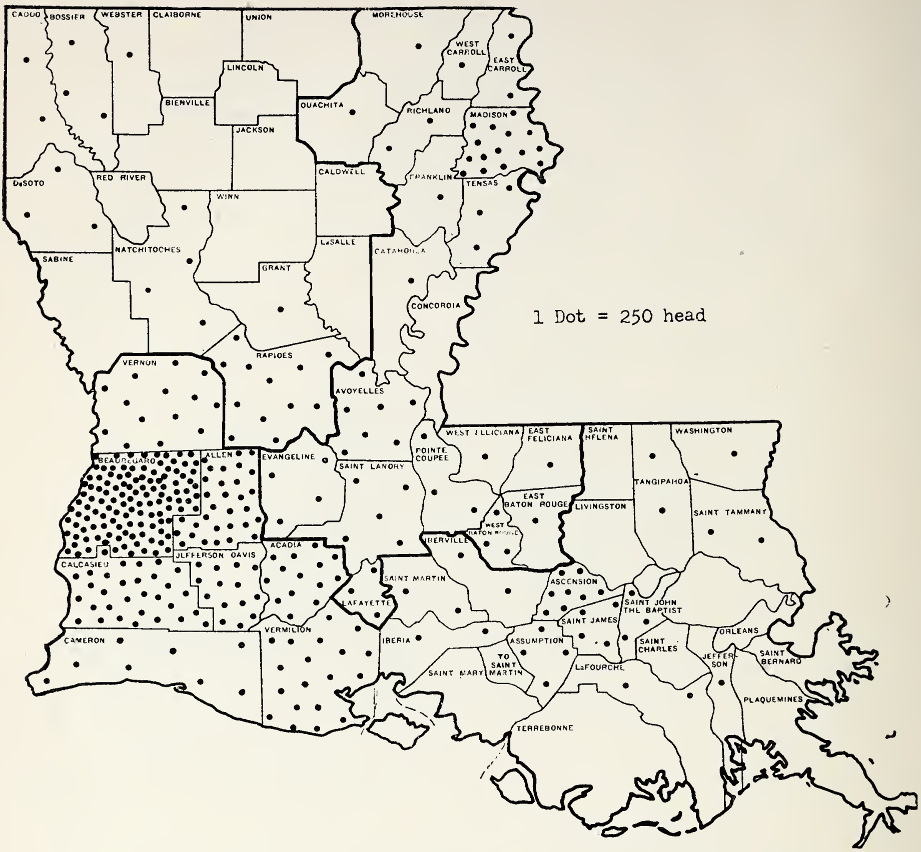

Figure 3. Distribution of Sheep and Lambs in Louisiana, by Area, 1950

weather conditions, current and prospective market prices, feed supply and price, condition of pastures, and other factors.

The seasonal pattern of marketings is about the same in the various parts of the state, and is similar to that of the Southern Region as a whole.

Classes of Livestock Sold

Approximately two-thirds of the cattle and calves marketed by producers in the state during 1950 were sold for slaughter, 21 per cent were sold as stockers and feeders, 12 per cent were for breeding or dairy purposes, and 3 per cent were veal calves (Figure 6). There were variations from one area of the state to another in the proportion of cattle and calves in each class, but the amount of difference was not significant. In general, the areas where dairying was prevalent had greater sales of veal calves and dairy cattle. A slightly higher proportion of animals sold

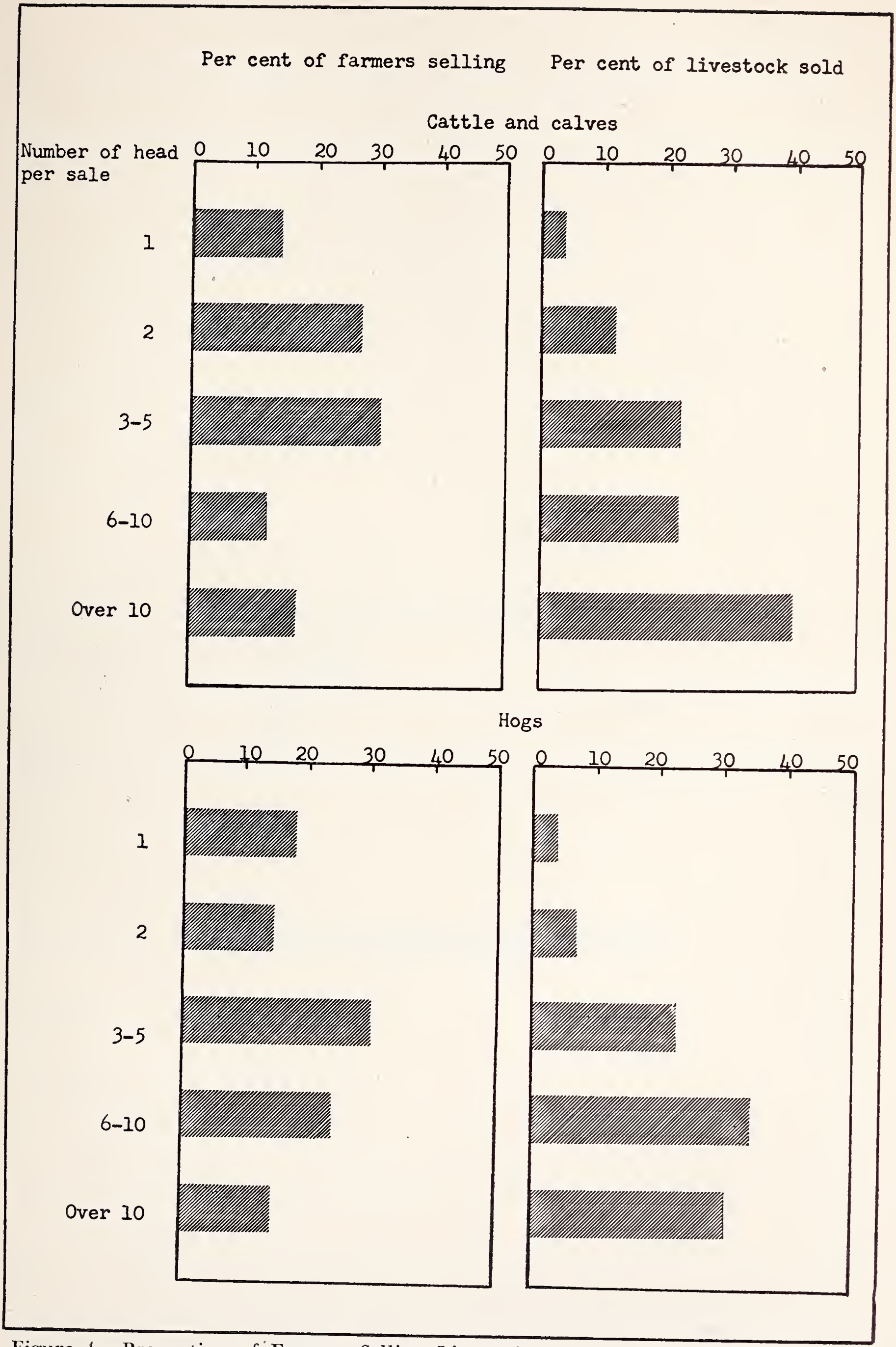

Figure 4. Proportion of Farmers Selling Livestock and Proportion of Livestock Sold in Various Size Lots, Louisiana, 1950

by producers in the Delta and Silt Loam and Gulf areas were for slaughter.

Seventy-two per cent of the hogs sold by farmers were classed as slaughter animals, 23 per cent as feeders, and 5 per cent as breeding stock. A greater proportion of the hogs sold in the Gulf area were feeders and breeding stock than in the upstate areas where more hogs are finished out for market.

Ages of Livestock Sold

The nature of the beef cattle industry in Louisiana is indicated by the fact that two-thirds of sales by producers were of animals under one year old (Figure 7). About a fourth were cattle two or more years of age. These proportions may be expected to vary from time to time, depending on relative prices for different classes of cattle, whether producers are building up or reducing the size of their herds, and other factors.

Most of the hogs sold by producers were under a year old. Sales of older hogs were relatively small.

Weights of Livestock Sold

The average weight of all cattle and calves sold by the producers included in the state-wide survey was 483 pounds (Table 4). Animals sold for slaughter averaged 466 pounds, largely because of the high proportion of calves in this class. In general, weights average higher in the Delta and Silt Loam area than in the other areas of the state. The average weight of hogs sold was 168 pounds.

Average weights vary from season to season and year to year because

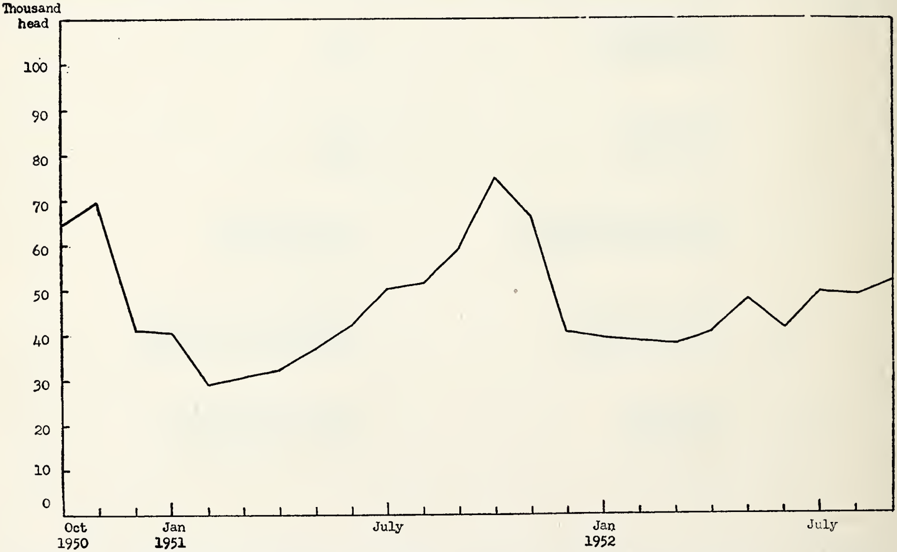

Figure 5. Number of Cattle and Calves Sold by Louisiana Auctions, by Months, October 1950-September 1952

of differences in the time of marketing and condition of animals. In years when pastures are good and feed plentiful average weights of livestock sold may be higher than in more unfavorable years.

Markets Used

Auctions have become the major outlet for Louisiana farmers having livestock to sell. Seventy-one per cent of total farm sales of cattle and calves and 72 per cent of the hogs were sold through auctions in 1950 (Figure 8). The importance of auctions varies considerably in different sections of the United States. The proportion of cattle and calves going to auctions amounted to 10 per cent in the Corn Belt, 44 per cent in North Carolina, and 76 per cent in Alabama.[4] In the Corn Belt most livestock is shipped to terminal markets or sold locally to dealers and packing plant buyers.

Terminal markets, such as New Orleans, Memphis, and Fort Worth, were the second most important outlet used by Louisiana pro-

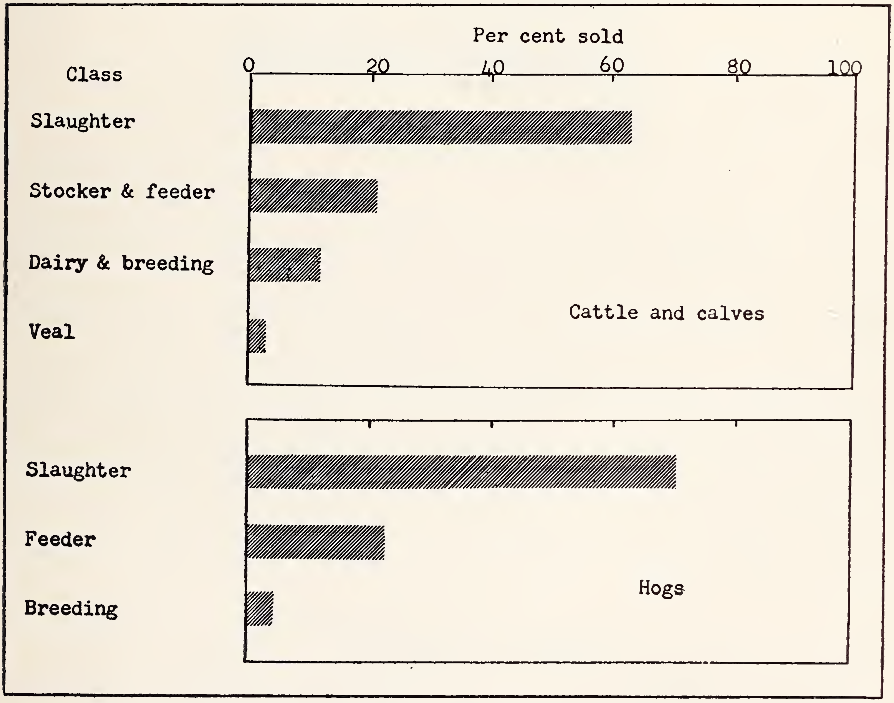

Figure 6. Proportion of Cattle and Calves and Hogs of Each Class Sold by Louisiana Producers, 1950

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[4] See: (1) *Marketing Livestock in the Corn Belt Region,* South Dakota Agri. Exp. Sta. Bul. 365, 1942; (2) *Livestock Marketing Practices of North Carolina Farmers,* Agri. Exp. Sta. Bul. 376, Sept. 1951; (3) *How Alabama Farmers Buy and Sell Livestock,* Ala. Agri. Exp. Sta. Bul. 281, March 1952.

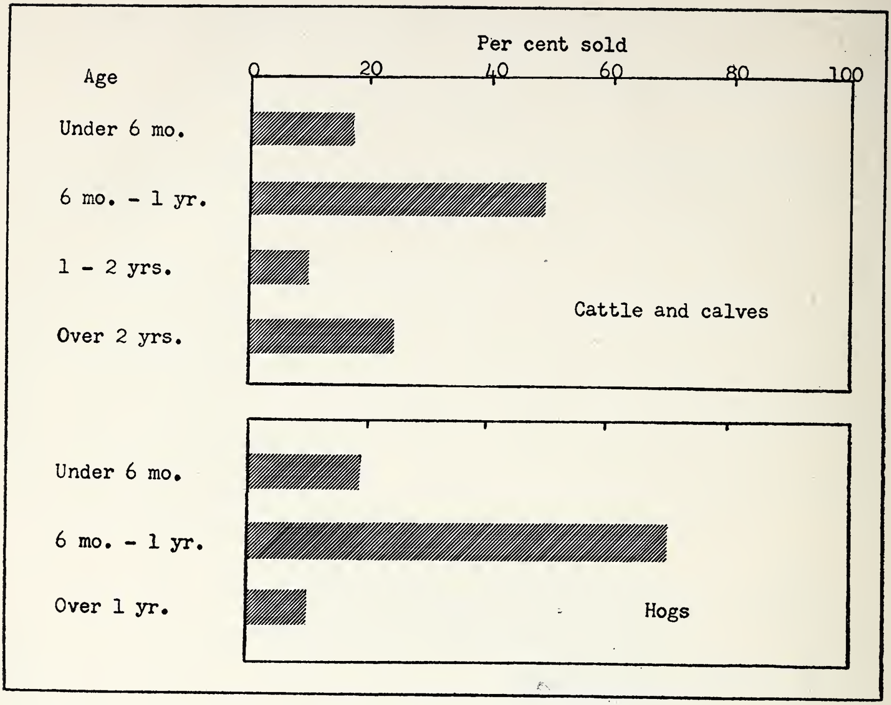

Figure 7. Proportion of Cattle and Calves and Hogs of Different Ages Sold by Louisiana Producers, 1950

ducers. About 12 per cent of the cattle and calves and 15 per cent of the hogs were sold through markets of this type.

Auctions handle a higher proportion of farmers' livestock in some areas of the state than in others. For example, 79 per cent of the cattle and calves sold by farmers in the Plains area of central and north Louisiana went through auctions, but in the Delta and Silt Loam and Gulf areas the percentages were 69 and 66 per cent, respective-

Table 4. Estimated Average Weight of Cattle and Calves Sold by Louisiana Producers, 1950

Age	Classes of animals			
	Slaughter	Stockers and feeders	Dairy and breeding	All cattle and calves
	(Pounds)			
Under 6 mo.	287	231	195	273
6 mo. - 1 yr.	422	392	376	417
1 yr. - 2 yrs.	643	531	549	575
2 yrs. or older	798	735	735	770
Average	466	541	464	483

ly (Table 5). Dealers and trucker-buyers were more important in the Delta and Silt Loam area than in other sections, handling 16 per cent of the cattle and calves. A considerable proportion of these animals later were sold through auctions; however, there is not yet any complete information on the movement of livestock after it leaves the farm.

Table 5. Proportion of Cattle and Calves Sold by Louisiana Producers Through Various Market Outlets, 1950

Market outlet	Area			
	State	Delta-Silt Loam	Coastal Plains	Gulf
	(Per cent)			
Auction	71	69	79	66
Terminal market	12	14	3	17
Dealer or trucker buyer	11	16	7	8
Farmer	3	1	9	3
Packing plant	1	*	2	*
Other	2	----	----	6
Total	100	100	100	100

*Less than 0.5 per cent.

Terminal markets received 12 per cent of the cattle and calves sold by farmers in the state, but the percentage varied from 3 per cent in the Plains area to 17 per cent in the Gulf area. Farmer-to-farmer sales were more common in the Plains area than elsewhere. Sales by producers to packing plant buyers at the farm or at the plant were not a prevalent practice. Packing-plant buyers in Louisiana purchased most of their livestock at auctions or by other means rather than directly from producers.

Distance Producers Go To Market

The 44 livestock auctions in Louisiana are so located throughout the state that most producers are fairly close to one or more. More than two-thirds of the producers included in the 1950 survey were less than 31 miles from the auctions used by them (Table 6). Frequently, however, a producer may not patronize the auction nearest to his farm. In general, the larger producers are more likely to go to more distant

Table 6. Proportion of Farms Selling Livestock That Were Located Specified Distances from the Auction Market Used, Louisiana, 1950

Area	Miles to auctions used				
	Under 16	16-30	31-45	Over 45	Total
	(Per cent)				
Delta	32	39	17	12	100
Coastal Plains	19	35	9	37	100
Gulf	49	32	7	12	100
State	34	35	12	19	100

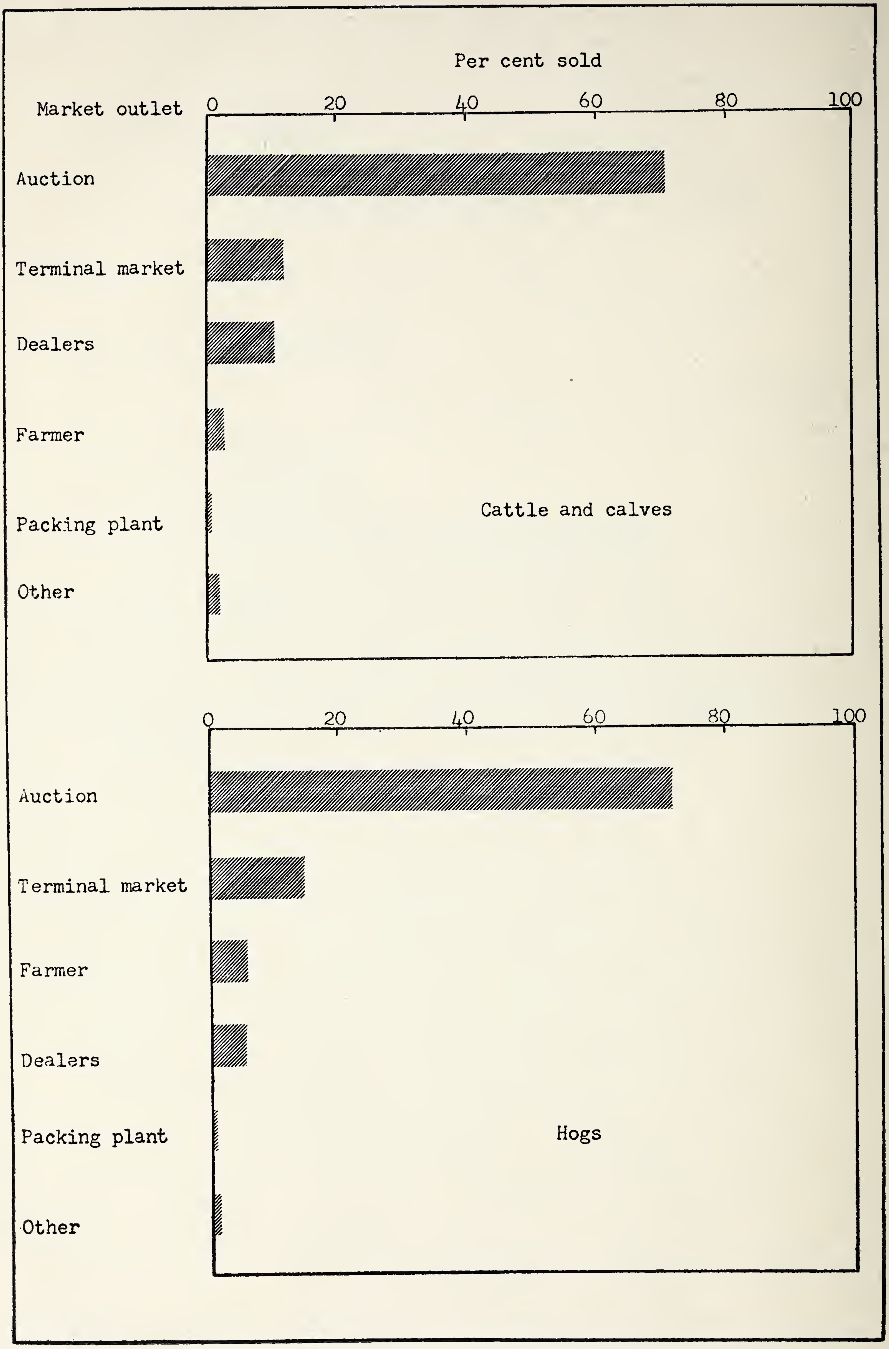

Figure 8. Proportion of Cattle and Calves and Hogs Sold by Louisiana Producers Through Various Market Outlets, 1950

markets than are smaller producers. This is indicated by the fact that only 19 per cent of the producers in the survey patronized auctions more than 45 miles from their farms, but they sold 36 per cent of the livestock.

Transportation Used

About two-thirds of the producers selling livestock at auctions and other markets used their own trucks or trailers to haul the animals to market. There were some differences between areas of the state in transportation practices. For instance, the use of hired trucks or buyers' trucks was more common in the Delta and Silt Loam area. The larger producers made slightly greater use of hired trucks than did smaller producers. In some sections auctions provide or arrange for transportation of livestock as an inducement to farmers to patronize the auction.

The use of hired or buyers' trucks is more prevalent in other parts of the United States than in Louisiana. This practice appears to be increasing throughout the country.

Sales at the Farm

Only 12 per cent of the cattle and calves and 7 per cent of the hogs were sold at the farm by producers included in the state-wide survey. Many producers who do not keep posted on market conditions feel that their animals will bring more nearly the market price when sold under competitive conditions at auctions.

There were some differences among classes of livestock in the proportion sold at the farm. In general, a higher proportion of breeding, stocker, and feeder animals were sold at the farm than was the case with slaughter animals. For instance, only 6 per cent of the slaughter cattle and calves were sold at the farm, as compared with 28 per cent of the stockers and feeders. A similar relationship existed for different classes of hogs.

Livestock Purchases by Producers

Livestock producers in Louisiana are also buyers of considerable numbers of livestock. Fifty per cent of the producers included in the survey bought cattle and/or calves in 1950, and 29 per cent bought hogs and/or pigs (Table 7). Purchases comprised 20 per cent of sales for cattle and calves and 38 per cent for hogs. In the case of cattle, farmers bought mainly stockers and feeders or animals to be used as herd replacements, for expanding herds, or for dairy purposes. Most of the hogs bought were feeders. The number of animals bought in relation to the number sold is dependent to a large extent on whether producers are increasing or decreasing the size of their herds. In 1950 producers appear to have been holding back some heifer calves and yearlings and generally building up the size of herds. Farmers in the Delta-Silt Loam area bought more cattle, in relation to sales, than did those in other areas of the state. This probably was because of more extensive feeding operations.

Table 7. Buying Practices of Louisiana Livestock Producers, 1950

Item	Cattle and/or calves	Hogs and/or pigs
Per cent of producers who bought	50	29
Number of animals bought as per cent of number sold	20	38
Class of animals bought (per cent of purchases)		
Slaughter	2	2
Stockers and/or feeders	52	93
Breeding and/or dairy	46	5
Total	100	100
Per cent bought from:		
Auctions	43	64
Other farmers	46	19
Other sources	11	17
Total	100	100

Nearly 90 per cent of the cattle and calves bought by farmers were obtained from other farmers directly or through auctions, the proportion from each source being about the same. Other farmers were the most important source of dairy and breeding stock. About half of the stockers and feeders were obtained through auctions and the remainder from a variety of sources.

Marketing Problems

In the survey livestock producers were questioned about the nature of their marketing problems, if any. In general, there appears to be reasonable satisfaction with present marketing arrangements. To a majority of producers the system of auction selling represents a substantial improvement over previous methods of selling. This is particularly true among the smaller producers. Auctions provide a year-round market for all classes of livestock, sales are for cash, the producer can see his animals sold, weighing facilities are available, and the producer ordinarily feels that his livestock is sold under conditions of competitive bidding among buyers.

Even though the present system of marketing generally is satisfactory, some producers have expressed complaints about practices followed. Because the criticisms did not follow any definite pattern, no attempt has been made to classify them as to importance or frequency. Some of the more common comments are discussed briefly below.

Marketing Charges. Producers frequently comment on the charges assessed for marketing their livestock. Many feel that the charges are too high, or that there is occasional discrimination among producers as to the rate charged. Louisiana auctions usually charge a commission which is based on a percentage of the gross sales value of the livestock. The most common rate is 4 per cent, but ranges from 3 to 5 per cent. This is higher than the rate in many important livestock areas, but lower than in some. Rates in the United States range from 1 to 10 per cent, depending on class of animals sold, type of market, location, and other conditions. In the Western States the average is only slightly more than 1 per cent. Rates in some of the Southern States are higher than in Louisiana. Charges at terminal markets are frequently lower than at auctions.

Fair comparisons of rates charged by selling agencies are difficult to make unless the services provided by the agencies are known. Further study of the problem is needed before it can be determined whether Louisiana producers are paying fair, excessive, or bargain rates to have their livestock sold.

Some producers feel that the practice of charging a flat percentage of the value penalizes high-quality, high-value animals. Since the services performed are the same for sellers of both good quality and poor quality, a fixed charge per head appears to some to be more equitable.

Market Information. Producers frequently do not have adequate information on current prices, price trends, market demand, supply conditions, and other factors needed to help them decide on the most advantageous time and place to sell their livestock. Even when terminal livestock market quotations are received by radio, newspaper, or other means it is difficult to apply this information to local livestock because of differences in location, quality of animals, age and weight, local market preferences, or terminology.

The Louisiana State Department of Agriculture and Immigration has made considerable progress in developing a system for reporting prices at selected local markets. Some auctions provide a good service to their patrons by keeping them informed on prices, prospective demand, and other conditions through mailed reports and personal contacts.

Diseases. The rapid shift to auction selling of livestock has made disease control more difficult in many respects. In spite of improved control measures the disease problem is one of great concern to the livestock industry of the state.

Small Auctions. In some areas auctions have been established where the livestock population is small. The number of animals handled in these auctions is low and often not sufficient to attract many buyers. This may result in less competition and possible lower prices to producers, as well as reduced returns to the auction management. Some producers, particularly the smaller ones, continue to patronize these agencies because of the convenience of selling through them. However, the concentration of large numbers of animals at a market is generally more conducive to efficient marketing and more favorable returns to producers.

One possible solution to the problem of small sales is to emphasize a particular class of livestock periodically, encourage producers to bring in this class of animals on these sales days, and publicize this to buyers in order to attract them to the sale. For example, on one sales day each month fat calves could be featured, on another day stockers and feeders, and so on. Of course producers would be free to offer animals of other classes, but the concentration of large numbers of animals of one class would attract some buyers who might not otherwise be justified in attending the sale because of the small offerings of classes of animals they wish to buy. Some auction operators are attempting to follow this procedure presently. Care must be taken to maintain a reasonable balance between supply and demand. If supply is relatively small, buyers may not come back; if the market is overly supplied, producers may not receive full market prices.

Time Required to Sell. The practice of selling animals individually at auctions is extremely time consuming for sellers, buyers, and auction employees. While large auctions offer greater possibilities for marketing efficiencies and keener competition, the method of selling is a limiting factor. This problem has been met in some areas by sorting animals into even-running lots and selling a lot at a time instead of an individual animal.

Injuries. Injury to live animals during transit to and from market, or at the market, results in bruised carcasses which are reduced in grade and value. Injuries are caused by neglect, rough handling, poor facilities, failure to properly segregate animals, and by wildness of animals. Facilities and handling practices have improved considerably, but there is opportunity for still more improvement, particularly in some markets.

Hazards in Buying. Some producers report that it is risky to buy animals at auctions to put in herds because of diseases, physical defects, or other undesirable characteristics, such as "fence-breaking," wildness, etc. These comments are more frequently heard among those purchasing dairy herd replacements. Of course these hazards exist in buying animals regardless of the type of market used, but there often is less recourse when buying at an auction even though most auction operators try to safeguard the interests of both buyers and sellers.

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Fungicide Tests on Fall Cucumbers In Louisiana, 1938-1951

By

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F. J. LeBeau and N. L. Horn

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FUNGICIDE TESTS ON FALL CUCUMBERS IN LOUISIANA, 1938-1951

By

J. G. Atkins, Jr., A. G. Plakidas, W. F. Wilson, Jr.,
F. J. LeBeau and N. L. Horn[1]

Cucumbers have been grown commercially in Louisiana for about seventy years. Early accounts indicate that in the beginning the crop was relatively free of serious diseases and insect pests, but not long after the industry had become established, a blight (downy mildew, *Peronoplasmopara cubensis*) appeared which made cucumber growing unprofitable. The growers soon learned to use Bordeaux spray to control this disease. Insecticides were eventually added to the Bordeaux spray until it became standard practice to spray the cucumbers with a mixture consisting of 4-4-50 Bordeaux plus 2 to 4 pounds of lead or calcium arsenate and 1 pint of nicotine sulphate per 50 gallons. While this practice proved fairly satisfactory, it left much to be desired. In the first place, Bordeaux, although giving satisfactory control of mildew, often caused severe injury or burning of the foliage and stunting of the plants with consequent reduction in yields. Second, the insecticides used in the mixture often gave poor control of the insect pests, particularly of the pickle worm.

In cooperation with the Department of Entomology, spray and dust tests were started in 1938 in an effort to find a treatment which would equal or excel the fungicidal quality of Bordeaux mixture, cause less injury to the vines and also control the insect pests. In addition to downy mildew, anthracnose (caused by *Colletotrichum lagenarium*) also became a serious, but rather sporadic, disease of the fall cucumber crop. Because of this, since 1944 the various fungicides were evaluated for the control of both anthracnose and downy mildew. In contrast with downy mildew, anthracnose was not a serious disease each year. Anthracnose developed and became destructive only during rainy growing seasons.

Although the various fungicides have been tested for the control of cucumber foliage diseases in a number of states in addition to Louisiana, the publications covering the results obtained will not be reviewed in this bulletin. In general, the objective of the tests in such states was to control downy mildew, the most serious foliage disease. For example, in North Carolina, one of the commercial copper fungicides was considered the most economical material for the control of downy mildew (3). Preliminary reports of the Louisiana tests have been published (1, 2, 4, 5, 6).

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[1] Assistant plant pathologist and formerly graduate assistant, plant pathologist, associate horticulturist and superintendent Fruit and Truck Experiment Station, formerly assistant plant pathologist and assistant plant pathologist, respectively.

SYMPTOMS OF DOWNY MILDEW AND ANTHRACNOSE

Two different leaf diseases or blights seriously damage cucumbers in Louisiana. Many growers in Louisiana have failed to recognize anthracnose when present along with downy mildew. However many have recognized that they were unable to obtain good control of their "leaf blight" with copper fungicides in certain years. As an aid in distinguishing these two leaf diseases or blights of cucumbers their characteristics are listed in Table 1. Leaf symptoms of the two diseases are shown in Fig. 1 and Fig. 2.

TABLE 1. Distinguishing symptoms of downy mildew and anthracnose

Characteristic	Downy Mildew	Anthracnose
Shape of spots	Generally angular	Circular to oval
Color of spots	Yellowish	Gray to brown
Size of spots	About ¼ inch	¼ to ¾ inch
Underside of spots	Frosty	Similar to upperside
Appearance of old spots	Brownish with center intact	Center cracked across or dropped out
Initial appearance in field	Light, scattered infection	Severe infection in a limited area

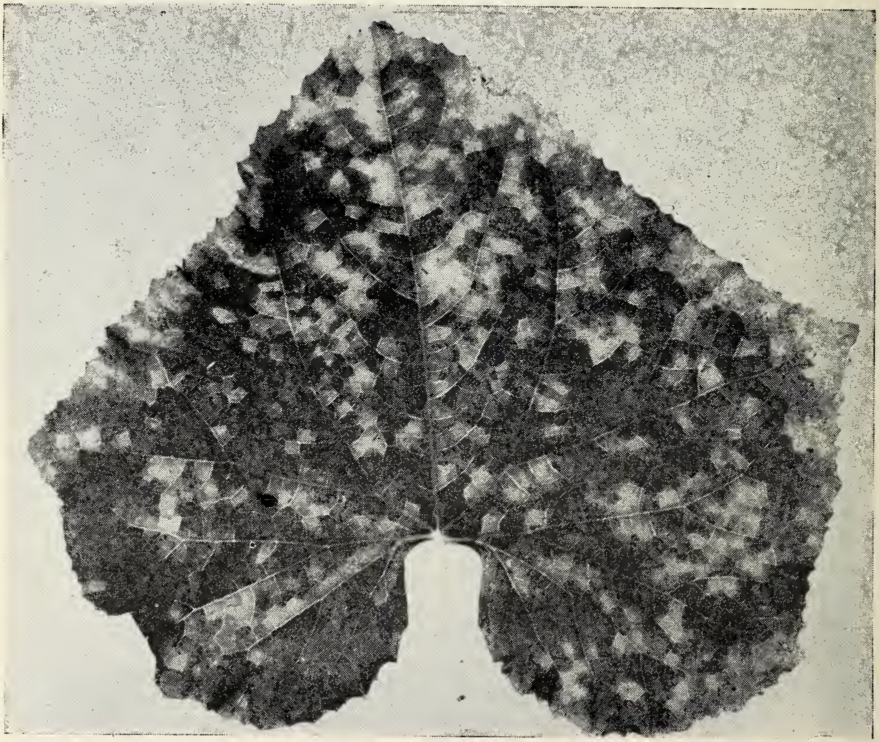


FIGURE 1.—Symptoms of downy mildew on a cucumber leaf.

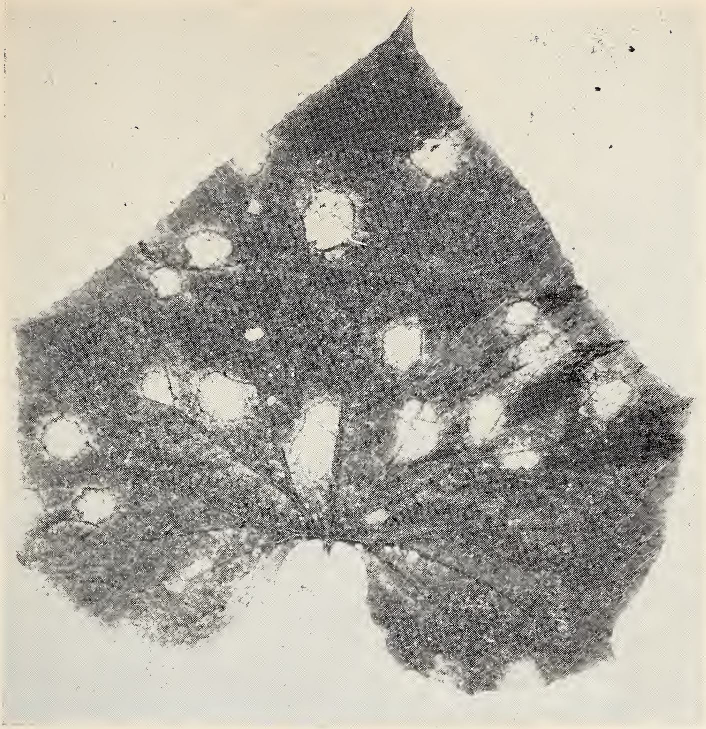


Figure 2.—Anthracnose infection on a cucumber leaf.

The downy mildew fungus causes yellowish to brownish angular spots on the leaves which when numerous coalesce to kill large areas or the entire leaf. A "frosty" or "downy" covering, rather dark in color, may be seen on the underside of the spots, particularly in the early morning. This downy covering contains large numbers of spores which are carried by air currents to healthy leaves, healthy plants or nearby fields. The smaller or younger spots appear water soaked when the leaves are wet with dew. The centers of the older spots are brownish in color owing to a killing of the invaded area. As the disease becomes severe the vines grow poorly, the plants are nearly defoliated and only a few marketable cucumbers are produced. Severely diseased fields appear yellowish or brownish from a distance. Downy mildew generally first appears about the middle of September on the fall crop but does not generally become severe until early October.

Leaf spots caused by the anthracnose fungus are circular to oval in shape, gray to brown in color and ¼ to ¾ inch in diameter. The fungus kills the leaf area within the spot rather rapidly so that the spots are generally not yellowish as with downy mildew. With strong winds or heavy rains the larger spots break across or else the center falls out to leave a ragged hole. When severe, anthracnose causes nearly complete defoliation, poor vine growth, reduced yields and poor quality fruit. Disease symptoms generally do not appear on the fruit during the picking season. Anthracnose generally appears first on a single plant or a few plants in a small area in a field. Spores are produced in abundance during humid weather but must be carried to healthy leaves or plants by physical means, generally by splashing or windblown rain. The spores are not carried by wind during dry weather as in the case of downy mildew. Conditions prevailing during dry weather are not favorable for spread or establishment of the anthracnose spores. Anthracnose causes damage only during wet seasons when conditions are favorable for the spread and development of the disease.

SPRAY AND DUST TESTS, 1938-1951

Since 1938, cucumber fungicide tests were conducted each year, except 1940 and 1941, by one or more of the writers. As yields were not recorded in 1943 and 1947, the results of these tests are not included. Most of the tests were conducted at the Fruit and Truck Experiment Station, near Hammond, Louisiana, within the commercial area centered in Tangipahoa Parish. Horticultural practices such as fertilization, varieties, time of planting, cultivation, irrigation, and grading were those recommended by the Louisiana Agricultural Experiment Station and were comparable with those used by a majority of the commercial growers. Rotary hand dusters were used for most of the dust applications made in the early morning or late afternoon. A Bean power sprayer was used for most of the sprays. The spray or dust applications were made every three or four days beginning when the plants were quite small. After 1944 cryolite and Black Leaf "10" or Black Leaf Dry Concentrate were used as insecticides in the dust mixtures. Prior to 1944 various insecticides were used and these were applied only as needed. All of the spray and dust formulae tested, number of spray or dust applications, number of replications, size of plots, planting dates, harvest dates, yields of No. 2 grade fruit, disease control ratings, severity of Bordeaux injury and weather conditions varied somewhat from year to year and influenced the interpretation of results based upon yields but cannot be given in detail or discussed. Also not listed are a number of fungicides which were not promising after one or more tests. The tables are thus partial summaries of the various yearly tests. Although yields of U.S. No. 1 fruit have been used primarily in evaluating the fungicides tested, observations as to plant injury and control of downy mildew and anthracnose have also been used.

For convenience the tests are summarized for three time periods: 1938-1942, comparison of Bordeaux mixture and Bordeaux substitutes with no fungicides; 1944-1946, comparison of commercial copper fungicides and Fermate, an organic fungicide, with Bordeaux mixture; and 1948-1951, evaluation of various organic fungicides.

When the fungicide tests were started in 1938 Bordeaux mixture, 4-4-50, was commonly applied with hand or knapsack sprayers at least twice weekly. Although nearly all of the growers sprayed their fall cucumber crop, a few growers used no control measures for insects and downy mildew. In the 1938, 1939 and 1942 tests summarized in Table 2 control plots receiving no fungicide were included. The results of these tests demonstrated that Bordeaux mixture gave good control of downy mildew with large yield increases. As the necessity of controlling downy mildew was clearly demonstrated in the early tests, plots receiving no fungicide were not included in the later tests. Bordeaux mixture or Tri-basic copper sulphate were then used as standards for comparison.

Although the commercial copper fungicides when used as sprays or dusts generally gave higher yields than Bordeaux mixture, observations indicated that the yield increases could not be attributed to better control of downy mildew but rather to less injury to the vines. Actually Bordeaux mixture gave better control of mildew than the commercial or fixed copper fungicides tested as Bordeaux substitutes. However Bordeaux caused serious injury to the cucumber vines. Bordeaux-injured plants exhibited one or more of the following symptoms: (1) Central portion of leaf or margin scorched, (2) older leaves brittle and stand upright, (3) margin of leaf smooth with a downward cupping (as a result of earlier marginal burning) and (4) plants dwarfed. Fig. 3 illustrates one type of Bordeaux injury. Injury from Bordeaux spray was considered to be more severe and to be more important in reducing yields on cucumbers grown without irrigation or insufficient irrigation in dry years. In

TABLE 2. Effect of fungicides used as sprays or dusts on yields of cucumbers—1938 to 1942.

(Yields in bushels per acre, U.S. No. 1 grade)

Treatment	Concentration	1938*		1938		1939		1942	
		Yield	Inc.	Yield	Inc.	Yield	Inc.	Yield	Inc.
None[1]		41.2	-----	137.7	-----	82.5	-----	35.3	-----
Bordeaux spray[2]	4-4-50	83.4	42.2	163.7	26.0	148.5	66.0	89.2	53.9
Copper spray[3]	3-50	106.5	65.3	257.1	119.4	193.0	110.5	80.6	45.3
Copper dust[4]	18%, 10%	70.2	29.0	202.8	65.1	-----	-----	112.4	77.1

*Baton Rouge test. No irrigation.

[1] Cryolite dusted on young plants in 1938 and periodically in 1939 and 1942.

[2] Calcium arsenate and nicotine sulphate added to spray in 1939 and 1942. Plants dusted with cryolite while small in 1938.

[3] Spray Cop in 1938 and 1939. Tri-Basic Copper Sulphate in 1942. Cryolite and nicotine sulphate added to spray periodically in 1939 and 1942. Plants dusted with cryolite while small in 1938.

[4] Dust contained 18% Spray Cop or approximately 6% metallic copper in 1938 and 1939. The 1942 dust, 10% Tri-Basic Copper Sulphate (5.3% metallic copper). Alternate applications of dust with and without arsenicals and rotenone in 1938 and 1939. 1942 dust contained 30% cryolite.

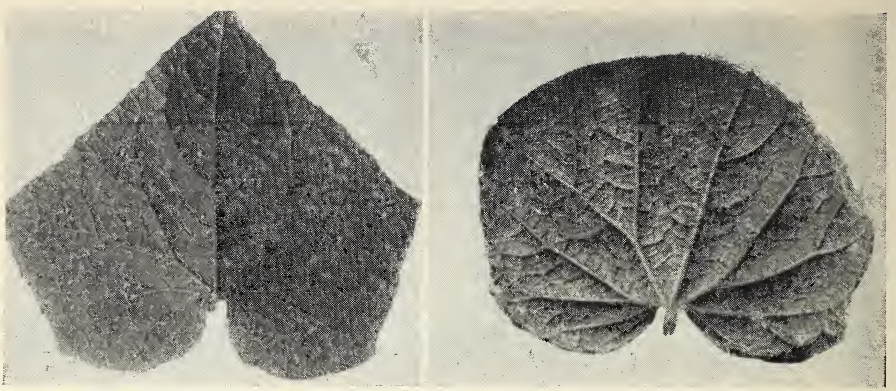


FIGURE 3.—One type of Bordeaux injury on right. Normal leaf on left.

general, Bordeaux injury, particularly dwarfing, was considered to be more severe in seasons of low rainfall even with irrigation.

The 1938 tests, as well as those for other years, demonstrated that Bordeaux mixture gave good control of downy mildew at low cost but caused rather severe injury. Some of the early tests with the commercial copper sprays or dusts were not too satisfactory. However as more information was obtained as to the effective concentration of fungicides, selection of insecticides and time and frequency of applications, excellent results were obtained, as shown in Table 3.

TABLE 3. Comparison of various fungicides with Bordeaux mixture on cucumber yields, 1944 to 1946. Yields in bushels per acre.

Treatment	Concentration	1944 Yield	1944 Diff.	1945 Yield	1945 Diff.	1946 Yield	1946 Diff.
Bordeaux spray[1]	4-4-50	108.6	---- --	232.8	---- --	94.0	---- --
Copper dust[2]	12%	114.5	+5.9	222.2	−10.6	130.0	+36.0
Copper dust[2]	8%	133.2	+24.6	154.8	−78.0	---- --	---- --
Cuprocide dust[3]	5%	105.5	−3.1	244.3	+11.5	---- --	---- --
Fermate dust[3]	10%	99.7	−8.9	460.9	+228.1	150.0	+56.0
Copper spray[4]	2-50	115.3	+6.7	------ --	---- --	---- --	---- --

[1] Lead or calcium arsenate, 4 lbs., and nicotine sulphate, 1 pt., per 50 gallons.

[2] Tri-Basic Copper Sulphate, 1944 and 1945. Copper A Compound, 1946. Dust contained cryolite (30%-1944, 20%-1945 and 1946) and 10% Black Leaf "10" (1% nicotine).

[3] Contained cryolite (30%-1944, 20%-1945 and 1946) and 10% Black Leaf "10" (1% nicotine).

[4] Cryolite, 4 lbs., and nicotine sulphate, 1 pt., per 50 gallons.

Beginning with the 1944 tests, a second foliage disease or blight, known as anthracnose, became an important disease and all treatments were evaluated for the control of both downy mildew and anthracnose. Fermate (ferric dimethyl dithiocarbamate, 70%), the first organic fungicide tested (see 1945 results in Table 3), gave yields considerably higher than the copper fungicides when anthracnose was severe. Examination of the test plots showed that Fermate gave good control of both downy mildew and anthracnose. The copper fungicides gave good control of downy mildew but poor control of anthracnose. Bordeaux mixture gave somewhat better control of anthracnose than did the commercial copper fungicides. Fig 4B illustrates the control of anthracnose afforded by Fermate in comparison with a copper fungicide.

Yellow Cuprocide caused injury to the cucumber plants in 1944 at the concentration used. Some of the other commercial copper fungicides, such as Copper Compound A and Tri-Basic Copper Sulphate, caused slight injury, particularly a slight marginal chlorosis of the leaves, in a number of tests. However the injury was not severe as with Bordeaux mixture.

After 1946 emphasis was placed on testing various dust formulations, particularly those containing organic fungicides, rather than on spray mixtures. By this time a large number of growers had shifted from the use of Bordeaux mixture and knapsack sprayers to commercial dusts and rotary hand dusters. The growers have justifiably preferred dusting to spraying since this practice reduces labor by at least 50 per cent, gives better control of insects and eliminates the necessity of mixing the spray material.

In addition to Fermate, Dithane Z-78 and Parzate (both containing zinc ethylene bisdithiocarbamate, 65%) were found in tests since 1946 to give good control of both anthracnose and downy mildew and high yields, as shown in Table 4.

TABLE 4. Yields given by several organic fungicides in comparison with a standard copper fungicide, 1948 to 1951. Yields in bushels per acre.

Fungicide	Concentration*	1948		1949		1950		1951	
		Yield	Diff.	Yield	Diff.	Yield	Diff.	Yield	Diff.
Tri-Basic Copper Sulphate	13.5%	231.1	-----	201.3	-----	428.2	-----	94.2	-----
Fermate	8.0%	203.3†	−27.8	206.6	+5.3	466.5	+38.3	147.2	+53.0
Dithane Z-78	8.0%	240.5	+ 9.4	238.8	+37.5	475.4	+47.2	174.5	+80.3
Parzate (dry)	8.0%	195.4	−35.7	216.4	+15.1	454.3	+26.1	154.6	+60.4
Orthocide 406	8.0%	-------	-----	210.6	+ 9.3	450.6	+22.4	147.8	+53.6
Crag Potato Fungicide	8.0%	-------	-----	228.4	+27.1	417.4	−10.8	110.7	+16.5

*Percentages refer to amount of the commercial product included in the dust mixtures on a weight basis rather than on the active ingredient basis. All dust mixtures contained 20% cryolite and 1% nicotine.

†Average three Fermate dusts, 4, 6 and 8%.

Parzate caused some injury to the cucumber plants in the 1948 tests but little or no injury in the later tests. However, Dithane Z-78 generally gave slightly higher yields and more vigorous plants than Parzate. In the 1948 and 1950 tests anthracnose was either not present or present in small amounts and did not affect yields. In the 1949 test anthracnose developed late in the season and did not drastically affect yields. However, in 1951 anthracnose injury was severe on plots dusted with relatively ineffective fungicides (see Fig. 4A) and yields were reduced. Orthocide 406 (N-trichloromethylthio tetrahydrophthalimide, 50%) gave promising results in 1949, 1950 and 1951 on the basis of yields and control of anthracnose and downy mildew. Crag Potato Fungicide (Copper zinc chromate complex) gave rather poor control of anthracnose in 1949 and 1951.

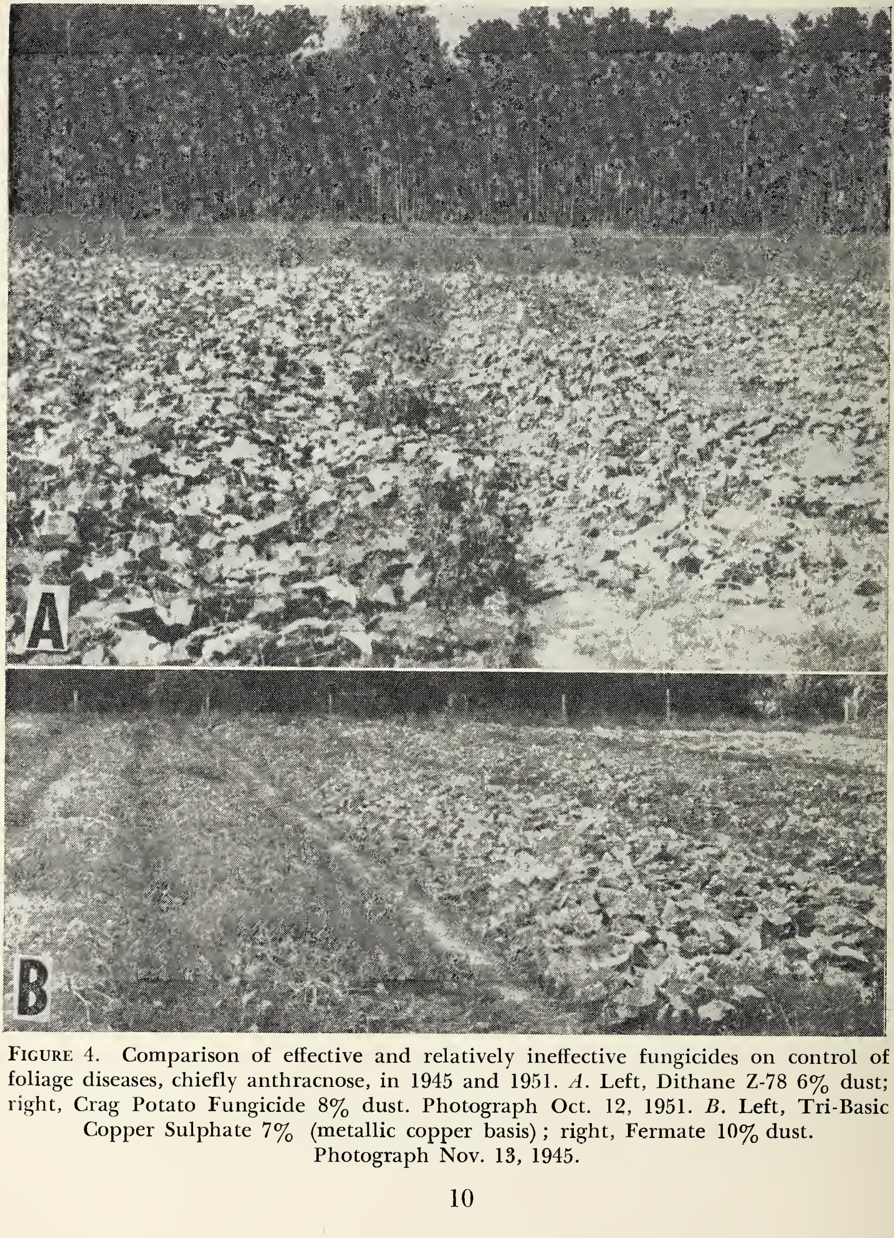
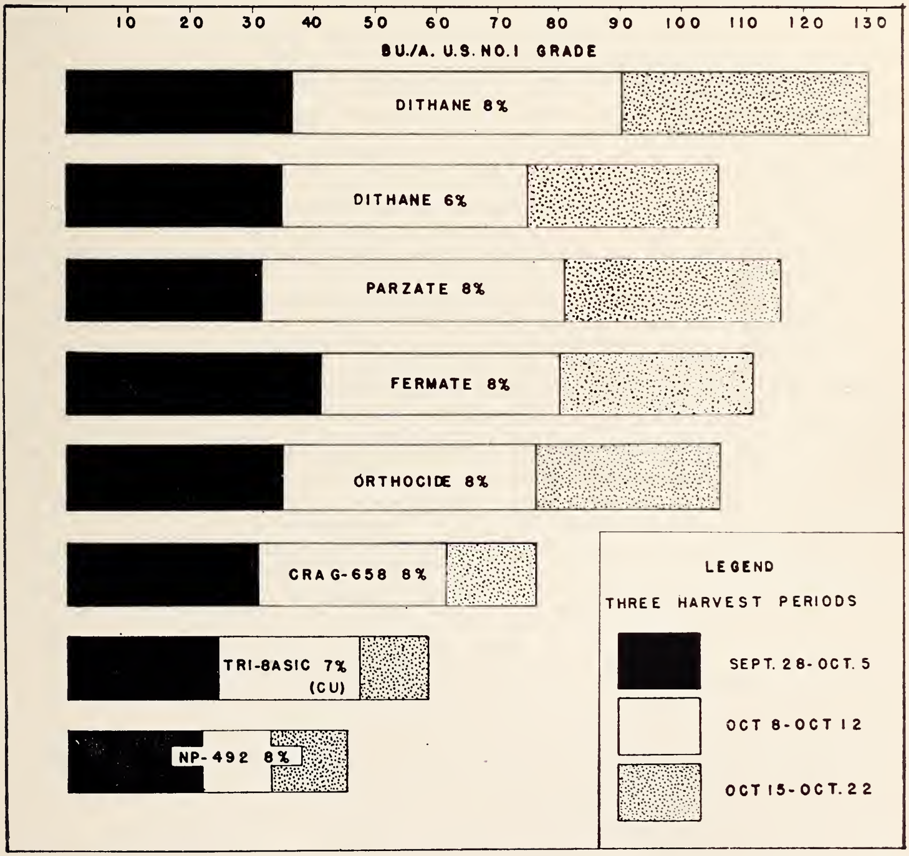


FIGURE 4. Comparison of effective and relatively ineffective fungicides on control of foliage diseases, chiefly anthracnose, in 1945 and 1951. *A*. Left, Dithane Z-78 6% dust; right, Crag Potato Fungicide 8% dust. Photograph Oct. 12, 1951. *B*. Left, Tri-Basic Copper Sulphate 7% (metallic copper basis); right, Fermate 10% dust. Photograph Nov. 13, 1945.

In certain tests anthracnose damage, consisting of defoliation, poor vine growth and poor yields, increased as the season progressed in plots receiving fungicides giving poor control of this disease. The cucumber plants in such plots were severely damaged or essentially dead before the end of the harvest season, as shown in Fig. 4, while those receiving effective fungicides continued growth until killed by frost. Effective treatments, such as Dithane Z-78 and Fermate, gave two to four extra pickings in comparison with ineffective fungicides. Similar results were obtained by grower cooperators in years when anthracnose damage was severe. Total yields for the season and total yields for three arbitrary harvest periods are shown in Graph I to illustrate the decrease in yields given by relatively ineffective fungicides in comparison with superior fungicides during the latter part of the harvest season. In 1951, Experimental



Graph 1. Comparative yields given by eight treatments for three arbitrary harvest periods to illustrate effect of differential control of anthracnose upon yields during the latter part of the season.

Fungicides NP-492 (Pennsylvania Salt Manufacturing Company), Tri-Basic Copper Sulphate and Crag Potato Fungicide gave low yields in the latter part of the harvest season as shown in the graph. The effective fungicides, Dithane Z-78, Fermate, Parzate and Orthocide 406, continued to produce satisfactory yields until picking was discontinued.

Along with the extensive tests at the Fruit and Truck Experiment Station a number of demonstrational tests were conducted in cooperation with commercial growers. Some of these tests are summarized in Table 5. In general, the newer fungicides considered promising on the basis of tests at the Experiment Station were compared with the material being used by the grower. Although certain of the tests were not replicated, the yields (recorded by the growers) corresponded with the general appearance of the respective tests plots. In comparison with copper fungicides, Dithane Z-78 and Fermate doubled yields in 1947 and 1949 when anthracnose was severe. In dry seasons when anthracnose was light or absent, marked differences were not apparent between plots receiving copper fungicides and Fermate or Dithane Z-78.

Table 5. Comparison of various fungicides in cooperative tests with commercial growers. Yields in bushels per acre.

Cooperator	Fungicide used by cooperator	Yield	Test Fungicide	Yield
B. Howell—1939	Bordeaux spray	372.3	Copper dust, 6%*	565.0
A. Bottolfs—1947†	Copper dust, 7%*	93.3	Fermate dust, 10%	387.1
A. Bottolfs—1948	Fermate dust, 10%	539.8	Copper dust, 7%*	466.3
C. Drude—1948	Fermate dust, 10%	347.5	Dithane Z-78, 10%	280.0
A. Bottolfs—1949†	Fermate dust, 10%	387.3	Dithane Z-78, 10%	404.9
F. G. Leder—1949†	Bordeaux spray	63.4	Dithane Z-78, 10%	123.5

*Metallic copper basis. Spray Cop, Copper Compound A or Tri-Basic Copper Sulphate.
†Anthracnose present in tests plots.

DISCUSSION

Yields of No. 1 grade or marketable slicing cucumbers have been used primarily in this bulletin in discussing the results of spray and dust tests. Since cucumbers with worm injury cannot be placed in No. 1 grade and many such fruits are encountered with poor insect control, results based upon yields of No. 1 grade cucumbers represent a combination of disease and insect control. Some of the early dust formulations were actually more promising on the basis of downy mildew control and freedom from injury than the yields in Table 2 indicate. Also, the arsenates used with Bordeaux mixture were inferior to cryolite. Thus three important factors influencing yields of No. 1 grade fruit are insect control, disease control and amount of vine injury. The yields of the later tests presented in Table 4 represent chiefly differences in disease control, since cryolite and nicotine were used in all dust formulations.

Spray mixtures containing commercial copper or organic fungicides, cryolite and nicotine sulphate gave satisfactory results, particularly from the standpoint of yields. However this combination cannot be recommended since, according to Experiment Station entomologists, the nicotine sulphate included for the control of aphids would not be effective unless an alkaline material, such as soap or lime, was added to the spray mixture. But cryolite cannot be used in combination with lime. Consequently none of the fungicides can be recommended for use as sprays, for lack of materials considered satisfactory for the control of aphids and insects on cucumbers in Louisiana.

Although the relative increase (or decrease) in yields for the various fungicides varied from year to year, the yield data from the various tests constitute a good evaluation. From a statistical standpoint some of the differences in certain of the tests were not significant. In other tests differences in yields between fungicides were statistically significant but differences in appearance of the plots were clearly evident, as shown in Figure 4. In the cooperative tests with commercial growers, as well as those at the Experiment Station, the fungicides which doubled the yields and gave differences in disease control as illustrated in Figure 4 recommended themselves to the growers.

From a practical standpoint the selection of a fungicide-insecticide treatment involves cost of ingredients, cost of application, amount of labor available, probable market price of cucumbers and average "expected" yields per acre. Experimental results for a period of years and numerous observations of commercial fields indicate that a grower should produce an average yield of at least 200 bushels per acre with recommended pest control and horticultural practices, unless very adverse weather conditions prevail. The ingredients for Bordeaux mixture cost less, on an acre basis, than the required amount of dust. However dusting results in a labor saving of at least 50 per cent. Primarily for this reason dusting became popular in Louisiana. Dusts containing one of the organic fungicides cost more than the copper dusts but, when properly used, provide protection or "insurance" against the destructive losses of anthracnose.

SUMMARY

Anthracnose and downy mildew are serious leaf diseases on the fall cucumber crop in Louisiana. Practically all growers recognize that diseases and insects must be controlled in order to produce a profitable crop. Downy mildew generally causes serious losses each year unless controlled. Anthracnose, a sporadic but very destructive disease, results in serious losses only during wet seasons or following a period of rainy and stormy weather, particularly tropical storms. In the cucumber fungicide tests started in 1938 anthracnose did not become a factor until about 1944.

In the early tests Bordeaux mixture was found to give good control of downy mildew with marked yield increases in comparison with plots which received no fungicide. However Bordeaux injury was frequently severe. Dusts containing 7 per cent metallic copper and insecticides were found to give good control of mildew and insects, little injury to the cucumber plants and higher yields than Bordeaux mixture. Dusts containing one of the copper fungicides and insecticides came into wide use in Louisiana.

In later tests, 1944 to 1951, the commercial copper fungicides were found to give poor control of anthracnose in comparison with certain of the organic fungicides when conditions were favorable for the anthracnose disease. Fermate, Dithane Z-78, Parzate and Orthocide 406 gave good control of both anthracnose and downy mildew, little or no plant injury and high yields. In comparison with copper fungicides, Fermate and Dithane Z-78 doubled the yields under conditions favorable for severe anthracnose damage. Since the copper fungicides gave poor control of this sporadic disease, certain of the organic fungicides are recommended as protection or "insurance" against the destructive losses of anthracnose.

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RECOMMENDATIONS

1. For the control of downy mildew and anthracnose use a dust containing Dithane Z-78, Fermate, Parzate or Orthocide 406 prepared according to the formula given below.

L.S.U. CUCUMBER DUST FORMULA[1]

Fungicide*	8 lbs.
Cryolite	20 lbs.
Black Leaf "10"	10 lbs.
or	
Black Leaf Dry Concentrate	7 lbs.
Diluent†	62 lbs. if Black Leaf "10" is used or 65 lbs. if Black Leaf Dry Concentrate is used

*Dithane Z-78, Fermate, Parzate or Orthocide 406.

†Talc, pyrophyllite or clay.

2. Dust should be applied twice weekly. New growth should be kept covered with a residue of the dust mixture. As anthracnose may cause damage on young plants, start dusting when the plants are small.
3. Thorough dust applications are necessary. The dust should be applied only when there is little or no wind—either early in the morning or in late afternoon.
4. Rotary hand dusters are satisfactory for applying the dust mixtures but should be maintained in good mechanical condition.
5. An application of straight or 50 per cent cryolite may be used for the control of beetles on very young cucumber plants.
6. The percentages of insecticides contained in the dust formula are considered sufficient for the control of the cucumber insects if the applications are made twice weekly. However if the aphid infection becomes heavy a stronger nicotine dust must be used.

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[1] Joint recommendation of the Departments of Plant Pathology and Research Entomology, Louisiana Agricultural Experiment Station.

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Louisiana Bulletin No. 473 **March 1953**

Vetch and Winter Pea Diseases In Louisiana

By J. G. Atkins, Jr.

Louisiana State University
and
Agricultural and Mechanical College
Agricultural Experiment Station
W. G. Taggart, *Director*

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Vetch and Winter Pea Diseases in Louisiana

J. G. ATKINS, JR.

The Austrian winter pea (*Pisum arvense*), common vetch (*Vicia sativa*) and hairy vetch (*V. villosa*) are the three most popular winter legumes used in Louisiana as cover crops for soil improvement purposes. The Singletary pea (*Lathyrus hirsutus*), *Melilotus indica* and a few other legumes are also planted in certain sections of the state. Some of these legumes have been used also for winter and spring grazing. Frequently the winter legumes have shown unsatisfactory growth. Diseases have been responsible for much of the difficulty in legume failures. During the past few years numerous diseased specimens of vetches and peas have been received by the Department of Plant Pathology, Louisiana Agricultural Experiment Station, from county agents, farmers and others interested in agriculture. Since 1947 the various diseases of vetch and peas have been studied, and this bulletin has been prepared to facilitate their identification and suggest methods of alleviating their damage.

The severity of the diseases has varied from year to year, from field to field and from one part of a field to another. Environmental conditions as influenced by rainfall and drainage were considered of great importance. The failure to follow recommended agronomic practices, as to time of planting, fertilization, seed inoculation and land preparation, was considered in part responsible for the poor results obtained in many cases. Davis, Hobgood and Brewer (1) showed that phosphate fertilizers and inoculation of the seed with nodule-forming bacteria gave marked benefit with Austrian winter peas and the vetches. Davis *et al.* (1), Wasson (7) and others have discussed the various agronomic recommendations.

The various diseases of peas and vetch in Louisiana were studied. These are decribed in this bulletin. As the diseases of Austrian Winter peas have been illustrated and described in a publication by Weimer (8), emphasis has been placed on vetch diseases. Along with a study of the diseases in the laboratory and greenhouse, all available species, varieties and selections or strains of the legumes were tested in nursery plantings for disease resistance or in larger test plots for yields or other evaluation. Although the field tests were made on the lighter or upland soil types, commercial plantings on other soil types will be observed.

Vetch Diseases

Although common (*V. sativa*) and hairy (*V. villosa*) vetch have been the two species most widely planted in Louisiana, several additional species were tested for disease resistance. Some of them are available in commercial quantities, present as mixtures in types commonly planted, or are observed growing wild along fence rows or in other waste places. Disease organisms cause leaf or foliage blights, black stem or stem rot and root rot. Although one organism may cause all three of these disease symptoms, the organisms are discussed separately.

1. **Anthracnose of vetch.** Two anthracnose fungi, *Colletotrichum villosum* Weimer and *C. sativum* Horn, cause leaf spots, stem lesions, general stem discoloration and early dying of vetch in Louisiana. In 1945 Weimer (10) reported *C. villosum* as causing anthracnose on vetch, particularly the hairy type. Common vetch, *V. sativa,* was considered resistant by Weimer. However, early observations by the writer showed that common vetch was frequently more severely damaged by anthracnose in Louisiana than hairy vetch. A study of the isolates made by the writer in 1947 along with those obtained later showed that a rather similar anthracnose fungus, *C. sativum,* caused a severe disease on common vetch. These studies by Horn and Atkins (2) and Horn (3) have been reported. Since the symptoms of the two diseases are similar, they are discussed together. In a comparative study of the two fungi by Horn (3) they were differentiated in laboratory and greenhouse tests in that *C. sativum* grew at higher temperatures, tolerated more acid media, showed less curvature of the conidia and was more pathogenic on common vetch.

Symptoms. Leaf spots are generally circular to oval, 2 to 5 mm. in size and light brown to gray in color, with a rather distinct, dark or reddish brown narrow border (Fig. 1A). When the spots increase in number and size defoliation results. The pods, stems, and petioles show similar spots. On the stems the spots are frequently numerous enough to coalesce and cause brown or nearly black discoloration (Fig. 1C and 1D). Such stems are severely damaged due to the necrosis or decay caused by the anthracnose fungi along with secondary organisms. The spots are elongated to oblique on the pods of hairy vetch (Fig. 1C), but generally circular to oval on common vetch (Fig. 1D). Under field conditions the anthracnose fungi probably do not attack the roots or stem tissues below the soil level. In greenhouse tests both of these fungi caused injury on the underground plant parts when they were added to the soil.

As with similar anthracnose diseases of other plants, rainy weather favors spread of the spores and development of the disease on vetch. Anthracnose generally appears during late January and gradually increases in severity when favored by proper weather conditions, with the result that the plants are severely damaged by late March or early April. In seasons of limited rainfall the disease causes less damage. However, when conditions are favorable *C. sativum* causes severe injury to common vetch, as shown in Fig. 1B, after it has made a fairly good vegetative growth. *C. villosum* has caused less damage on hairy vetch in Louisiana than the similar species, *C. sativum,* has caused on common vetch.

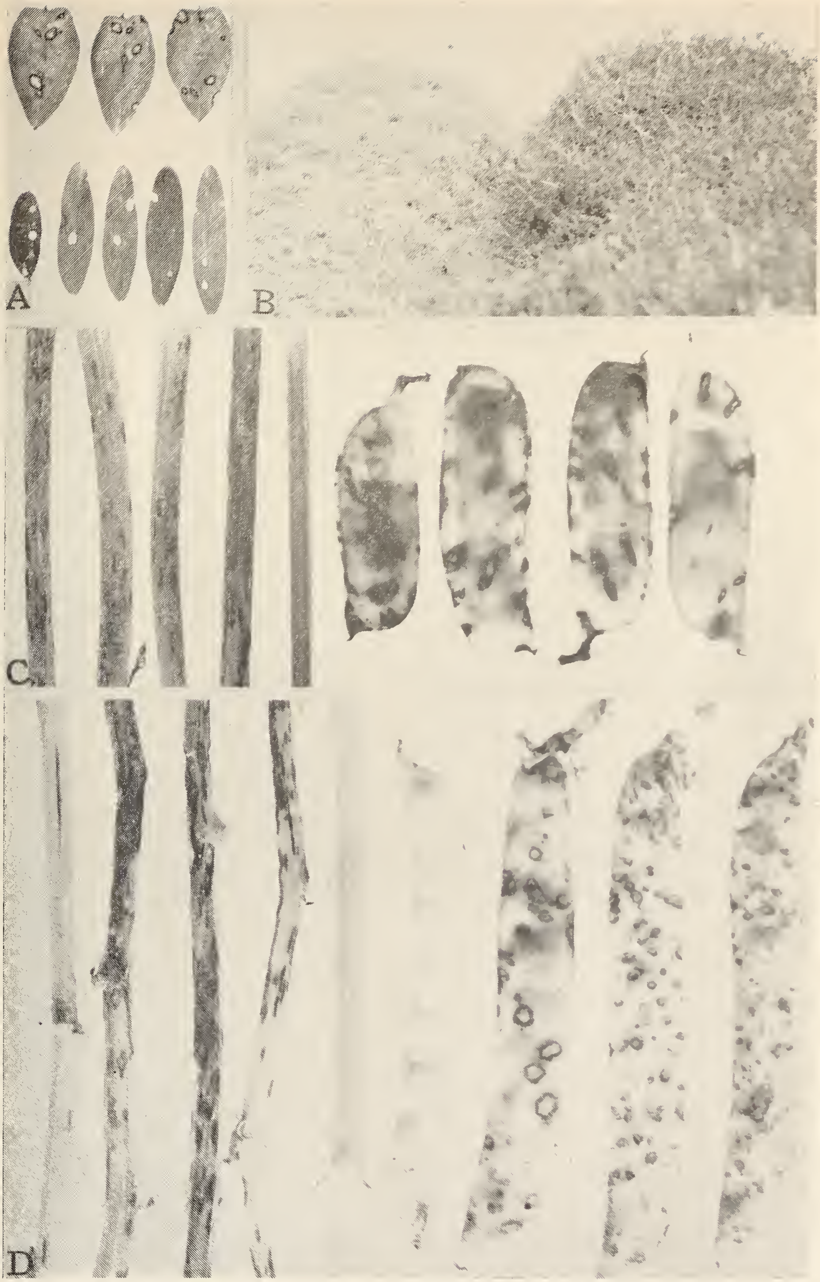

Fig. 1. Anthracnose of vetch. *A*. Leaf spots on common (above) and hairy (below) caused by *C. sativum* and *C. villosum,* respectively. *B*. On left, common vetch killed by *C. sativum* in comparison with resistant hairy vetch, on right. Natural infection. 1949-50 test plots. *C*. Spots on stems and pods showing *C. sativum* infection. *C* and *D* each include one healthy stem to the right of four diseased stems for comparison.

2. **Downy mildew** (*Peronospora* sp.). Since the downy mildew fungus cannot be cultured in the laboratory, this disease was observed only in the field. On the basis of field observations covering a four-year period, downy mildew may be characterized as a minor, cool weather disease of certain vetch species. Since downy mildew occurs during January and February when the other foliage diseases are generally light, it may be rather conspicuous.

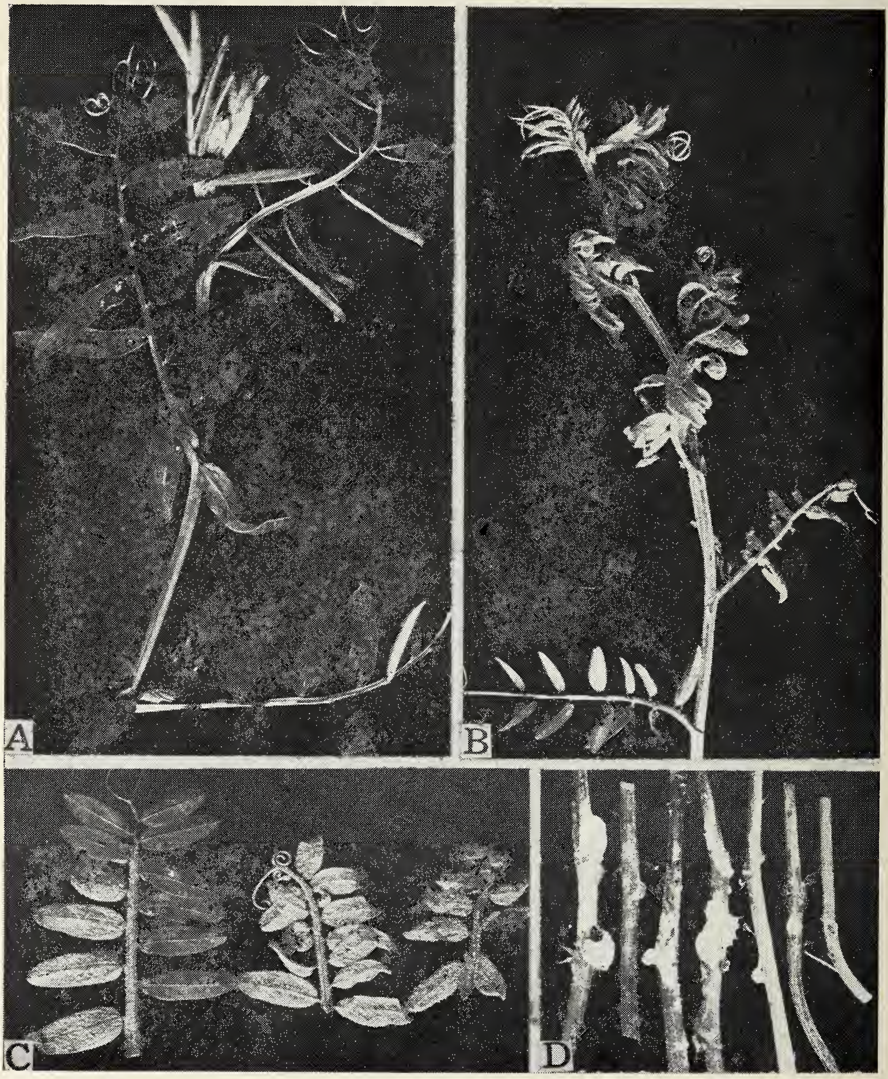

FIG. 2. *A*. Healthy smooth hairy vetch. *B*. Downy mildew on smooth hairy. *C*. Downy mildew on lower leaf surface of hairy vetch. *D*. Stem rot on common vetch.

Symptoms. The symptoms of downy mildew vary since the infection may be of a local nature or may be systemic. Local infections of the leaves result in chlorotic or light green spots or areas varying from a few millimeters in size to the size of the entire leaflet. The lower leaf surface generally shows a downy covering consisting of conidia and conidiophores of the fungus (Fig. 2C). Sometimes the downy growth of the fungus appears on the upper leaf surface.

In the case of systemic infection nearly all of the leaves and leaflets on a given stem or branch may be infected. The infected stem appears to be dwarfed and the leaves are grouped closer together. The lower leaf surfaces generally show a conspicuous downy covering varying from gray to purplish in color. Not all of the stems of a plant are infected. The infected plants or branches exhibit a distorted growth characterized by dwarfing and curling of the leaflets (Fig. 2B). The infected leaflets or terminal plant parts eventually become necrotic and darkened.

Of the cultivated vetch species only *V. villosa* (hairy vetch) and *V. dasycarpa* (woollypod vetch) were found to be susceptible. Narrowleaf vetch, *V. angustifolia,* growing wild in Louisiana, frequently shows downy mildew infection. The disease was never observed on common vetch, *V. sativa.* Woollypod vetch showed only light infection, though infection was frequently rather heavy on *V. villosa.*

3. **Botrytis leaf blight.** In Louisiana Botrytis leaf blight caused by *B. cinerea* must be considered a minor foliage disease. In greenhouse inoculations isolates of the fungus were found to be less pathogenic than some of the others studied. Weimer (9) also studied this disease.

Symptoms. The disease appears as reddish brown necrotic spots with rather indefinite margins. The lower leaves are more frequently attacked. Common vetch, *V. sativa,* and certain other species frequently show a considerable amount of the infection in late spring following periods of cool, damp or rainy weather. The stems and petioles also frequently show lesions which are reddish brown in color, with more definite margins than the leaf lesions.

As shown in Table 1, the susceptible species include *V. sativa, V. grandiflora* and *V. angustifolia.* Hairy vetch, *V. villosa,* was considered as resistant on the basis of the nursery observations and greenhouse inoculation studies. *B. cinerea* must be considered a common soil fungus frequently found on dead organic material but capable of causing disease symptoms on plants during cool damp weather or under conditions of poor aeration. The use of the old cotton stalks to support the vetch plants probably serves to reduce Botrytis infection. Although the fungus may attack vigorous leaves of certain vetch species, weakened tissues are more frequently invaded.

4. **Stem rot** (*Sclerotinia sclerotiorum*). In the nursery and in plantings of commercial strains at Baton Rouge stem rot was observed in 1951

Table 1. Relative Susceptibility of Ten Species of Vetch to Diseases, Cold Injury and Spider Mites.

Vetch species	Common name	Root rot	Colletotrichum		Botrytis	Downy mildew	Powdery mildew	Stem rot	Root knot	Spider mites	Cold	Vigor
			villosum	sativum								
V. sativa	Common	S	R	S	S	R*	R*	S	MS	S	S	Good
V. villosa	Hairy	R	S	R	R	S	R*	R*	S	R	VR	Good
V. benghalensis	Purple	R	S	R	R	R*	R*	R*	R	S	VS	Very good
V. grandiflora	Bigflower	S	R	S	S	R*	R*	S	MS	MR	R	Fair
V. pannonica	Hungarian	S	R	S	MR	R*	R*	R*	VS	S	R	Fair
V. dasycarpa	Woollypod	MR	S	S	MR	S	R*	R*	S	R	MR	Very good
V. articulata	Monantha	VS	S	S	MS	R*	R*	S	MS	R	MR	Poor
V. angustifolia	Narrowleaf	S	R	S	S	S	R*	S	R	S	MS	Poor
V. ludoviciana	Louisiana	S	S	R	R	S	S	S	R	S	MS	Very poor
V. hirsuta	Tiny	S	R	S	R	R*	R*	R*	MS	R	MS	Very poor

*Apparent resistance based upon field observations.

and 1952 during the late winter months. The lower portions of the stems, in contact with the soil or in dense growth, showed a general rotting, brownish in color with a white mycelial growth when attacked by this pathogen (Fig. 2D). Black sclerotia were frequently attached to the white mycelial growth on infected stems. Sclerotia were also found within the stems and on the soil surface beneath infected plants. The sclerotia serve to carry the fungus over the hot summer months. The sclerotia germinate the following winter with the production of apothecia, the fruiting stage of the fungus. Spores produced in the apothecia germinate and cause infection after falling in a location suitable for their development. Apothecia were found in plots in which vetch had been diseased the previous year. The fungus causing stem rot of vetch was considered to be the same organism as that causing the common rot of cabbage in Louisiana. Apothecia were found at the same time of year at two nearby locations following cabbage in one plot and vetch in another.

The varietal resistance of the various species of vetch was rather difficult to determine, since other fungi were known to be present on the lower stems in contact with the soil or in dense vegetative growth. For that reason the presence of the white mycelial growth and typical sclerotia were considered along with the condition of the stem in rating the various plants for resistance. Of the major species, *V. sativa* (common vetch) was considered to be susceptible and hairy vetch was considered to be resistant. Actually, all of the vetch species are probably susceptible under conditions favorable for disease development. The ratings for the various species in Table 1 are based on field observations for two years and limited greenhouse inoculations. The Sclerotinia fungus was isolated in the laboratory and used to inoculate vetch plants growing in steamed soil in the greenhouse. The isolates used caused stem rot as observed in the field plots. In addition to cabbage and vetch, lupines, melilotus, alfalfa and red clover are susceptible to Sclerotinia rot, as are many horticultural and ornamental plants. Various weeds are also attacked.

5. **Root rot** (*various fungi*). Quite a number of different fungi have been listed as causing root rot of vetch and peas (12). Several of these organisms were obtained from vetch in Louisiana. They included *Fusarium, Aphanomyces, Pythium* and *Rhizoctonia* species. The studies in Louisiana were concerned chiefly with the relative performance of the various vetch species on infested soil in field plots, since environmental conditions influence the effect of the complex of fungi involved in root rot. The laboratory and greenhouse studies were not extensive enough to determine which fungi were of the greatest importance.

Symptoms. Root rot symptoms consist of a killing of the small roots accompanied by a brownish discoloration. The necrosis generally also involves the larger roots and underground stem portions. Although the rotting of the underground part of the stem might be considered stem rot in a strict sense, it was included in the root rot complex in the studies. The aerial plant parts or foliage of plants with roots or underground stems affected by root rot show poor growth and a yellowish or reddish color. However, such symptoms may result from any serious injury to the stems near the soil surface.

Observations made in the nursery, in larger test plots at Baton Rouge, and in disease surveys of commercial plantings showed that hairy vetch and certain of the other species showed less injury from root rot than common vetch. Root rot and poor growth were associated with poorly drained areas and with fields where vetch had been planted continuously for a number of years. The relative susceptibility of the vetch species has been summarized in Table 2.

6. **Root knot** (*Meloidogyne* spp.). Although root knot is usually considered to be a warm weather disease, certain of the vetch species

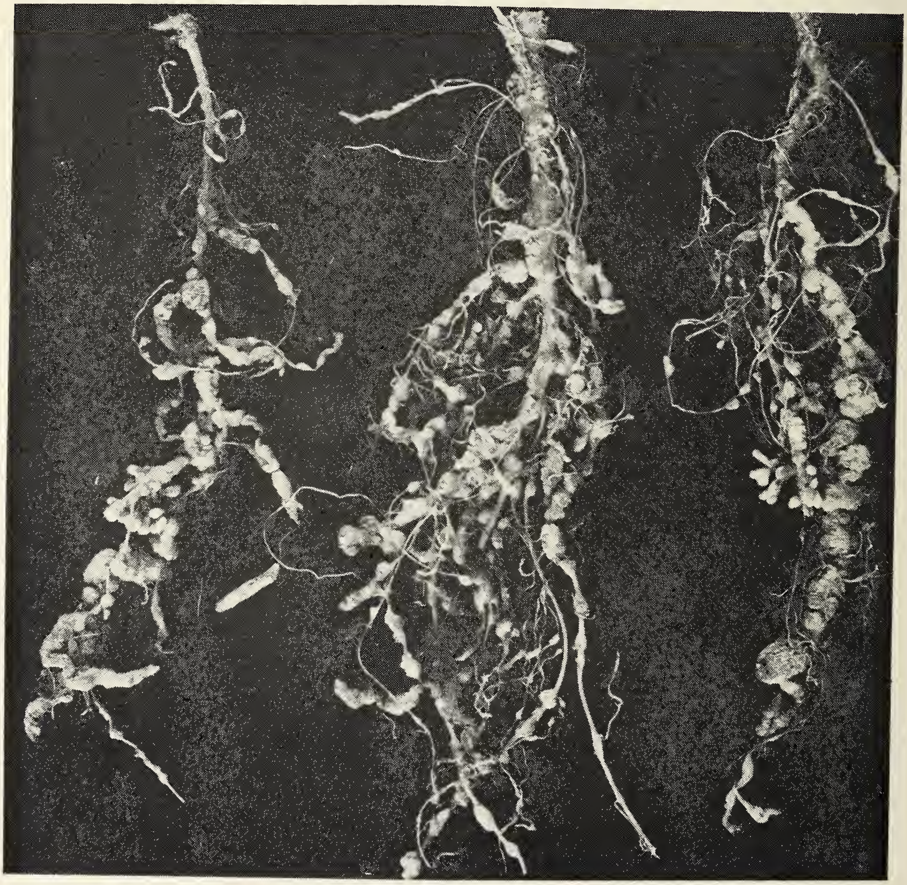

Fig. 3. Severe root knot on Hungarian vetch.

showed extensive gall production in test plots at Baton Rouge during the winter. Root knot has not been a common or serious disease of vetch in Louisiana. Only in the test plots at Baton Rouge was heavy infection observed. Plants collected at other locations in the state sometimes showed light infection. In the test plots at Baton Rouge plants of Hungarian (*V. pannonica*) and hairy (*V. villosa*) showed markedly reduced aerial growth when the roots exhibited extensive gall development. The damage observed on such plants in the test plots cannot be attributed entirely to root knot nematodes, since other types of nematodes and various soil-inhabiting fungi constitute a complex of disease organisms. The severity of root knot, as measured by the amount of gall production and effect on plant growth, varied greatly throughout the test plots. Severe root knot and a marked reduction in growth were generally associated. Common vetch (*V. sativa*) and certain other species showed less infection (gall production) and were considered as tolerant or resistant. Frequently both common and hairy vetch plants growing side by side were observed and examined. Generally common vetch showed good growth and little gall development on the roots while the hairy vetch showed poor growth accompanied by heavy gall production. Although none of the vetch species was immune, a number were considered resistant, as shown in Table 1. *V. dasycarpa* was particularly tolerant to root knot in that the plants showed excellent growth in spite of rather extensive galls on the roots.

Symptoms. The symptoms of root knot on vetch are similar to those on certain vegetable crops such as okra and tomatoes. They consist of galls or enlargements of the roots as shown in Fig 3. The galls vary greatly in size, shape and general appearance. They may either show no decay or exhibit extensive rotting caused by the soil fungi. When infection is severe, the vetch plants show poor growth and frequently have yellowish or reddish foliage as a result of accompanying root rot.

Several different species or strains of the microscopic worms known as nematodes cause root knot. Studies[1] of a preliminary nature in Louisiana indicate that most of the nematodes present in the test plots at Baton Rouge were *Meloidogyne incognita* and *M. incognita* var. *acrita.*

7. **Miscellaneous diseases.** Powdery mildew (Oidium sp.) commonly affects *V. ludoviciana,* Louisiana vetch, growing wild in the vicinity of Baton Rouge. With the exception of a trace of powdery mildew observed on *V. hirsuta* one year, only *V. ludoviciana* showed infection in nursery plantings. Since powdery mildew does not attack any of the agronomically desirable vetch species, the disease is of no economic importance.

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[1] Unpublished studies by Dr. W. J. Martin. Notes on file in Department of Plant Pathology, Louisiana Agricultural Experiment Station.

A leaf and pod spot of *V. ludoviciana* was collected several times on wild plants. A species of Cercospora, which was not identified, was consistently associated with the disease. The Cercospora was not found on any of the other vetch species.

Unidentified Ascochyta species were occasionally isolated from commercial seed and diseased vetch stems. A laboratory examination of many collections of diseased vetch indicated that the Ascochyta fungi were not of great importance on vetch, as compared with Austrian Winter peas.

Various other fungi have been reported on vetch (12). Some of these may occur in Louisiana, but they were not observed in the studies.

Pea Diseases

As diseases of peas of the Austrian Winter type have been described and illustrated in a publication by Weimer (8) and nearly all are identical with those on the garden or English pea (see La. Agr. Exp. Sta. Bul. 357 by A. G. Plakidas [5]), only limited descriptions of these diseases will be given. Furthermore, in the studies on pea and vetch diseases, the various seed lots of peas tested were found to show only limited differences in disease resistance in comparison with the vetches. Consequently, emphasis was placed on a study of the various vetch diseases and evaluation of the various species and strains for disease resistance.

1. **Ascochyta blights.** While the Ascochyta species, *A. Pisi, A. pinodella* and *A.* (Mycosphaerella) *pinodes,* attack the garden or English pea varieties, only the latter two species occur on Austrian Winter peas and similar selections. It was pointed out by Weimer (8) that the Austrian Winter peas are resistant to *A. pisi,* and the studies in Louisiana confirmed this fact. Although *A. pisi* was not found on Austrian Winter peas, the fungus was isolated from Creole and other garden varieties for a comparative study of the three species of Ascochyta. Since there has been some interest in the use of Creole peas as a winter legume for field plantings and occasional plants of this type may be found in fields as mixtures, the disease has been included in the study. Mr. C. B. Haddon, Northeast Louisiana Agricultural Experiment Station, St. Joseph, Louisiana, carried on selection work with Creole peas for a number of years in an effort to develop a pea with desirable agronomic characters. Definite tan to brown spots are produced on the leaves, pods and stems (Fig. 4B). The spots are generally somewhat sunken in appearance, particularly on the pods, with dark fruiting bodies near the center. In greenhouse tests isolates of *A. pisi* were found to be more pathogenic on Creole peas than on Austrian Winter or Dixie Wonder peas.

Weimer (8) reported that two other Ascochyta fungi cause serious damage on Austrian Winter peas. The symptoms consist of dark, general-

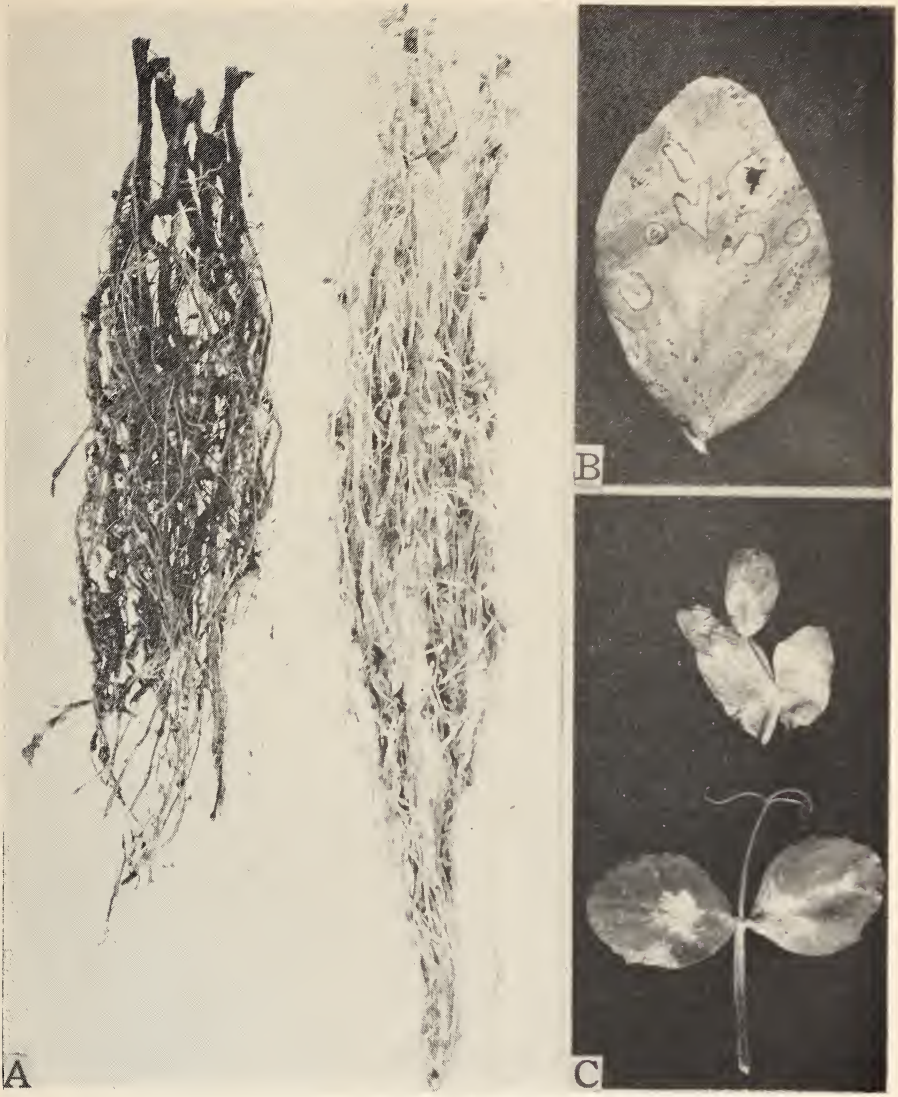

Fig. 4. *A.* Severe root rot on Austrian Winter peas on left in comparison with limited root rot on Singletary peas from field plots. *B. Ascochyta pisi* leaf spots on Creole peas. *C.* Appearance of downy mildew on Austrian Winter peas.

ly circular spots on the leaves and stems. When severe, nearly all of the lower leaves are killed and the stems are blackened. Hence, the name of "black stem." One of the fungi, *A. pinodella,* attacks the plants near the soil line and causes "foot rot" (Fig. 5A) . *A. pinodes* generally affects only the stems and leaves and was isolated less frequently than *A. pinodella* from diseased peas.

The Ascochyta fungi are carried in the seed. To date, no seed treatments have been found which will give satisfactory control. All seed lots tested were found to be infected. However, two selections from the U. S. Department of Agriculture, H-241 and H-277, generally showed somewhat less Ascochyta infection. Weimer (11) found that certain species of *Lathyrus* were highly resistant but that these could not be crossed with the Austrian Winter pea. He was not able to find a satisfactory source of resistance for use in breeding work (11). The two fungi are also known to live from year to year in the soil or in plant debris. Rotations are not entirely effective, since the fungi are seed borne.

2. **Downy mildew** (*Peronospora pisi*). The symptoms of downy mildew (Fig. 4C) on peas are quite similar to those of the same disease on vetch, which has been described in the previous section. Ordinarily downy mildew causes only limited damage and must be classed as a minor disease of peas. Frequently peas show rather heavy infection during the winter, but the disease does not cause extensive damage. During the late spring the disease decreases in severity. The plants from all seed lots tested in the nursery were found to be susceptible to mildew.

3. **Powdery mildew** (*Erysiphe polygoni*). During the spring months, particularly late spring, powdery mildew occurs as a very prevalent, conspicuous, severe and damaging disease. Unlike most other fungi, the powdery mildews grow on the surfaces of leaves and stems. The infected areas are white to grayish in appearance, due to the presence of mycelium, conidiophores and conidia. Heavily-infected plants grow poorly and die early. Fortunately, powdery mildew does not become severe until after the plants have made good growth, unless severely damaged by other diseases, and are nearly ready to plow under.

4. **Anthracnose** (*Colletotrichum pisi*). Diseased pea stems or leaves collected in the field and examined after holding in moist chambers for 24 to 48 hours frequently showed abundant development of a Colletotrichum which appeared to be *C. pisi.* Isolates of the fungus from Louisiana as well as one received from Wisconsin[1] were weakly pathogenic on Creole and Austrian Winter peas in greenhouse tests. A few brown spots were produced on the older, lower leaves. Ou and Walker (4) reported that *C. pisi* was a weak pathogen which invaded weak tissues or those already diseased by other fungi, chiefly the Ascochyta fungi. Walker (6) has suggested that the name of the fungus on peas should probably be listed as *C. truncatum.* The Louisiana studies based upon isolations and examinations of diseased material showed that this species of Colletotrichum was very prevalent on diseased peas. Although the fungus sometimes caused rather definite brown spots on the leaves and stems, greenhouse and field observations indicate that anthracnose is a minor disease of peas.

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[1] Received from Dr. D. S. Hagdorn, University of Wisconsin, Madison, Wisconsin.

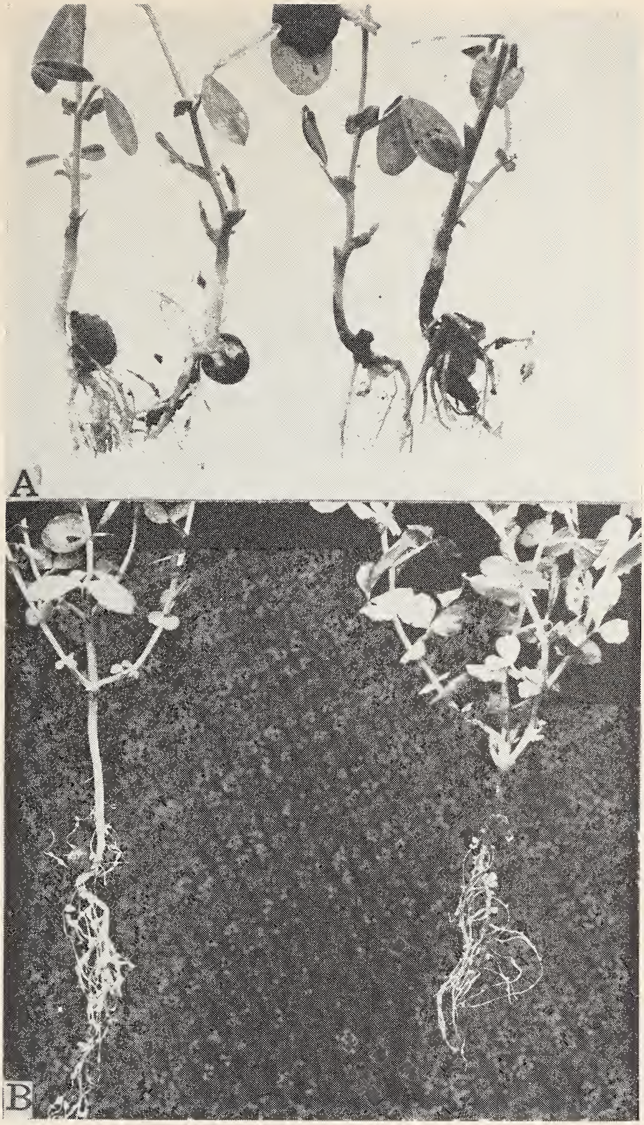

Fig. 5. *A*. Foot rot caused by *Ascochyta pinodella* on Austrian Winter peas on right from greenhouse test. On left, healthy control plants. *B*. Healthy pea plant on left compared with root rot plant on right. Natural infection.

Another anthracnose fungus, *C. sativum,* from common vetch was definitely pathogenic on Austrian Winter, Dixie Wonder and Creole peas in greenhouse tests. This disease was observed only on peas in test plots where it was present on common vetch or other susceptible species.

5. **Root rot.** Austrian Winter peas are quite susceptible to root rot (Fig. 4A, 5B) and the symptoms are similar to those given for vetch in a previous section. Affected plants show poor growth and yellowish or pale green to reddish foliage. Root rot has been more severe on peas planted on the same land in successive years. The plants on areas with poor drainage generally show more root rot.

H-241 and H-277, two selections from the U. S. Department of Agriculture, and the Creole pea were slightly more resistant to root rot than Austrian Winter or Dixie Wonder peas. However, the level of resistance was considered too low for alleviating the disease and all were more susceptible to damage from low temperatures. Hairy (*V. villosa*) and purple (*V. benghalensis*) vetch and Singletary peas (*L. hirsutus*) showed resistance to root rot and made satisfactory growth on infested soils where Austrian Winter peas made poor growth.

6. **Root knot** (*Meloidogyne* spp.) . To date root knot has not been of importance on Austrian Winter peas. Rather heavy root knot has been found on peas grown in test plots at Baton Rouge and in a few locations in the state. Heavily infested soil should be planted with resistant crops, such as oats, rye grass or Singletary peas.

7. **Miscellaneous diseases.** A number of other fungi have been reported as causing diseases on peas (6) . Some of these may occur in Louisiana but they were not detected in the studies. Weimer (8) listed leaf blotch caused by *Septoria pisi* as a rather important disease in Georgia and other southern states. The stem rot fungus, *S. sclerotium,* also attacks peas (8) but was not observed in Louisiana.

Bacterial blight (*Pseudomonas pisi*) was observed but was considered a very minor disease and was not studied. Peas growing near common vetch attacked by *C. sativum* frequently showed anthracnose. Since this disease was observed only on peas in test plots and not in commercial plantings, it cannot be considered of importance. A few plants showing the symptoms of mosaic or other virus diseases were observed, but because of the low percentage of plants affected the viruses were considered of little economic importance.

Diseases of Singletary Peas (*Lathyrus hirsutus*)

Although occasionally the Singletary pea (also known as Southern Winter pea, rough pea, Caley pea and wild winter pea) has shown poor growth, this variety was considered to be rather highly resistant to the diseases studied. In Louisiana, Singletary peas have been used for grazing and turning under, as in the case of Austrian Winter peas and the vetches, but they also have been used as a seed crop. In general, diseases and other pests have been more severe on peas approaching maturity as a seed crop than on younger forage or green manure plants.

1. **Ascochyta blight** (*Ascochyta* sp.). A few circular to oval brown spots were frequently found on the senescent leaves as the plants were approaching maturity. Spots or extensive necrotic areas were also frequently found on the stems and leaf petioles. The Ascochyta fungus was isolated and used in inoculation studies. Little infection developed on young plants grown in the greenhouse. Only the lower or older leaves showed any infection. Since the fungus failed to infect vigorous plants in greenhouse tests and attacked only senescent leaves or plants injured by the attack of spider mites in the field, the disease was considered of minor importance.

2. **Root knot** (*Meloidogyne* spp.) Although some root knot has been observed on Singletary peas grown in infested soil, this species of Lathyrus was considered highly resistant in comparison with hairy vetch, Austrian Winter peas and other Lathyrus species.

Tests in 1952 showed that *Lathyrus aphaca, L. tingitanus* and several unidentified species were extremely susceptible to root knot. The growth of *L. aphaca* was adversely affected by a combination of root knot nematodes and the complex of soil organisms.

3. **General stem and leaf blight.** Heavy growths of Singletary peas in contact with the soil surface during wet weather, or peas approaching maturity, generally show a dying of the leaves and a general browning of the stems. This type of injury was attributed to the common soil or decay organisms, whose activity had been favored by the environmental conditions prevailing. Various fungi, such as Botrytis, Fusarium, Rhizoctonia and Cephalosporium, were isolated.

Relative Susceptibility of the Vetches and Peas To Insect and Cold Damage

During the course of the investigations the various strains and species of vetch were found to differ greatly in their tolerance of low temperatures. Since a number of the different species of vetch and varieties of peas were evaluated for disease resistance and growth, records were also made of their susceptibility to cold damage. Weather conditions prevailing during the growth period of the 1949-50 tests with a low of approximately 13° F. provided excellent opportunities for evaluating cold resistance. Ordinarily such low temperatures are not frequent for south Louisiana. Drastic fluctuations in temperatures are not uncommon in Louisiana and probably influence the winter hardiness of many plants in addition to peas and vetch. Purple vetch, *V. benghalensis,* was considered the most susceptible of the various vetches to cold injury, as shown in Table 1. Hairy vetch, *V. villosa,* was the most tolerant. The various strains of common vetch (*V. sativa*) tested, including imported seed lots, showed a considerable amount of variation in their tolerance to cold. However, commercial common vetch was found to show considerably less cold tolerance than hairy vetch. Pea selections H-241 and H-277 were more susceptible to cold injury than commercial Austrian Winter and Dixie Wonder peas. Austrian Winter peas were less hardy than hairy vetch.

The spider mite, *Tetranychina apicalis* Banks, has been a serious pest on Singletary peas, *L. hirsutus,* raised either for a seed harvest or when used for grazing or winter cover. Since spider mite infestation was heavy in some of the strains in the nursery and commercial tests, records[1] were made as to their relative susceptibility. Hungarian vetch, *V. pannonica,* and purple vetch, *V. benghalensis,* were found to be the most susceptible. Hairy vetch showed less damage than common vetch, another susceptible species. The feeding of the spider mite causes a bleaching of the foliage, making the leaves a very light color. The differences observed between species may have been a matter of host preference rather than actual resistance.

Nursery Tests

The objectives of the winter legume disease studies were (1) to study and identify the various diseases and to evaluate the effect of environmental factors in an effort to alleviate damage from diseases, (2) to evaluate commercially available seed, and (3) to evaluate non-commercial strains, plant introductions and selections for potential use. On this account all available seed lots were included in the nursery plantings. These consisted of single or replicated plots of eight- to ten-foot rows planted on infested soil where Austrian Winter peas or common vetch had been grown for successive years. The nursery tests included various strains from the Division of Forage Crops and Diseases, a large number of introductions from the Division of Plant Exploration and Introduction, and local collections. Samples from commercial seed lots were included for comparison. The various entries were rated for resistance to diseases, insects, and cold resistance, vigor and growth, and, in some cases, seed production.

In the 1949-50 tests a large number of common vetch (*V. sativa*) introductions were included in the nursery tests. None of the introductions was superior to commercial common vetch from the standpoint of resistance to anthracnose, which completely killed most of them by late March. Although seeds were collected from a few promising plants, they were killed by cold weather the following year or the seed failed to germinate. Two strains, F.C. 29,933 and *V. alba* (presently considered a strain of *V. sativa*), showed some tolerance to anthracnose and root rot in that they gave better growth than the commercial common vetch. However, later tests showed that each of these strains was more susceptible to cold injury than commercial common vetch.

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[1] With Dr. L. D. Newsom, Department of Research Entomology.

Local collections of *V. angustifolia* (narrowleaf vetch), *V. ludoviciana* (Louisiana vetch) and *V. hirsuta* (tiny vetch) showed very poor growth and low disease resistance in comparison with the commercial vetches. One strain of narrowleaf vetch, F. C. 23,994, gave better growth than the local collections.

V. grandiflora (bigflower vetch), *V. pannonica* (Hungarian vetch), *V. articulata* (Monantha vetch), and *V. leavenworthii* were found to be lacking in vigor or disease resistance, or both, in comparison with other species.

In the various tests, strains of *V. villosa* (hairy vetch), *V. dasycarpa* (woollypod vetch) and *V. benghalensis* (purple vetch) were superior to common vetch in growth and disease resistance. However, purple vetch was severely damaged by cold weather and spider mites.

The relative resistance of ten vetch species to the various diseases, low temperatures and spider mites has been summarized in Table 1 on the basis of field plantings and greenhouse inoculation studies. Of the various species, *V. villosa* possesses the best combination of characteristics for successful growing in Louisiana. Purple vetch was considered lacking only in cold tolerance. *V. narbonensis,* not listed in Table 1, was found in limited tests to have good resistance to most diseases, including root rot and root knot.

Although a superior vetch selection was not obtained from the tests, the basic information as to disease, cold and spider mite resistance could be useful in a breeding program involving crosses of different vetch species. While seed lots of a given vetch species showed limited differences in disease resistance, differences between species were great.

Commercial Strain Tests

The commercial strains, such as Austrian Winter peas, common vetch and hairy vetch, were planted in replicated tests at Baton Rouge and certain other locations where winter legumes had given poor growth, particularly in Franklin Parish. In addition, a few non-commercial strains were included, when sufficient seed was available.

Yields, on a green weight basis, were taken in part of the tests. They are given in Table 2 with observations as to growth for the other tests. In the 1949-50 Franklin Parish tests only hairy vetch and Singletary peas made appreciable growth. Common and Hungarian vetch, Austrian Winter, Dixie Wonder and Creole peas made poor growth. Seed treatment chemicals, such as Arasan, Spergon and Phygon, did not show promise in controlling root rot of peas. Common vetch made fair growth in the 1949-50 tests at Baton Rouge, but was completely dead at the time of plowing under, as shown in Fig. 1B. As the writer was interested primarily in large differences in growth, which might be termed satisfactory and unsatisfactory (Fig. 1B, for example), yields were not taken for the 1949-50 tests. The two tests at Baton Rouge for which yields are given in Table 2 consisted of four replications for each legume. The yields for the 1950-51 Baton Rouge tests were greatly influenced by cold injury resulting from a low temperature of approximately 13° F. For example, the purple vetch was killed and the two pea selections, H-241 and H-277, were severely damaged. In the 1950-51 Franklin Parish test, purple vetch was protected from cold by snow and later made good growth.

Table 2. Relative Performance of Various Winter Legumes in Field Tests.

Legume	1949-50 Franklin Parish	1949-50 Baton Rouge	1950-51 Franklin Parish	1950-51 Baton Rouge	1951-52 Baton Rouge	1951-52 Franklin Parish
	(Relative Growth)			(Tons per Acre, Green Weight)		
Hairy vetch (Oregon seed)	Good	Good	Very good	6.3	7.9	5.5
Hairy vetch (Texas seed)	Good	Good	Very good	6.3	....	7.3
Common vetch	Poor	Poor	Good	4.1	7.3	0.0**
Willamette common	Poor	Poor	Good	5.0	....	....
Purple	....	....	Very good	0.0	8.1	6.0
Austrian Winter peas	Very poor	Fair	Very poor	1.9	5.1	....
Dixie Wonder peas	Very poor	Fair	Very poor	2.4	4.0	5.4
Singletary peas	Good	Fair	Good	2.9	6.8*	6.7*
Melilotus indica	....	....	Very poor	0.0	0.3	0.0
Crimson clover	....	....	Fair	4.5	2.7	0.0
USDA Pea 241	....	....	Poor	1.8	5.7	....
USDA Pea 277	....	....	Poor	0.9	6.8	....

*Contained hairy vetch as a mixture.

**Common vetch eaten by pigs. Estimated yield, 3 tons.

The results given in Table 2 show that hairy vetch consistently gave the best results for the test period. It was concluded that Dixie Wonder peas were not superior to Austrian Winter peas. Although U. S. D. A. pea selections H-241 and H-277 were considered somewhat more disease-resistant than Austrian Winter peas, the low level of resistance and their greater susceptibility to cold injury do not warrant a recommendation that they be planted. Common vetch strains F. C. 29,933 and alba gave lower yields in 1950-51 tests (yields not included in Table 2) than commercial common vetch as a result of cold injury, even though they were considered slightly more disease resistant. The poor or erratic results obtained with Crimson clover and *Melilotus indica* were probably due to planting the seed too deep or poor adaptation to the soil type.

Austrian Winter and Dixie Wonder peas gave varying results in the tests, depending upon the location and weather conditions. They gave poor growth when planted on land where the soil was heavily infested with disease organisms as a result of planting in successive years, but gave fairly good growth in some instances at other locations. In general, consistently good results were not obtained.

Singletary peas make most of their growth in late March or April and for that reason cannot be considered as a very satisfactory winter cover crop. However, they are considered a rather dependable legume. Singletary pea seed produced in Louisiana and containing from 20 to 40 per cent hairy vetch have given good results.

Summary

1. Although diseases cause poor growth and early dying of peas and vetch, other factors may be of equal or greater importance. Failure to follow recommended agronomic practices as to time of planting, method of planting, inoculation of seed, phosphate fertilization, and drainage frequently results in poor growth.
2. Even though recommended agronomic practices are used, winter cover crops often failed nearly completely, particularly where planted on the same land in successive years.
3. The major diseases of vetch and peas have been described and illustrated in this bulletin. The relative resistance of the various vetch species to the diseases present in Louisiana has been listed.
4. Root rot and two anthracnose diseases were found to be the principal diseases of vetch in Louisiana. Diseases of less importance were downy mildew, stem rot, Botrytis leaf blight and root knot.
5. Peas of the Austrian Winter type were found to be damaged by the same diseases that affect English or garden peas, except for *Ascochyta pisi.* The Ascochyta blights and root rot were considered the major diseases of peas in Louisiana. Powdery mildew causes a moderate amount of damage. Downy mildew, anthracnose and root knot cause less injury.
6. Singletary peas were found to be resistant to the fungi used in these studies.
7. The various legumes investigated differed greatly in their tolerance of low temperatures. Of the major commercial legumes, hairy vetch and Singletary peas were cold hardy. Common vetch and peas of the Austrian Winter type were damaged by extremely cold weather but were considered of moderate cold tolerance. Purple vetch was the most susceptible of the various peas and vetches to cold injury.
8. Of the legumes tested hairy vetch gave the best results in field tests at Baton Rouge and in Franklin Parish, where common vetch and Austrian Winter peas had previously grown very poorly.

Recommendations

1. Follow agronomic recommendations of the Louisiana State University Agricultural Extension Division or the suggestions of your county agent as to fertilizers, time of planting, inoculation of seed, method of planting, etc. Avoid planting on flat poorly drained land. Unless steps are taken to secure adequate drainage on low areas or fields, good growth cannot be expected.
2. Crop rotation or a change in crop sequence to include oats, wheat, rye grass or semi-permanent pastures is highly recommended for use where possible. Field surveys showed that diseases were less severe and growth was better in areas where legumes had not been planted in successive years.
3. The planting of Austrian Winter peas should be confined to land not planted to peas or vetch in the preceding three years. However, the grower must decide for himself which legume he should plant and what constitutes satisfactory growth.
4. Hairy vetch should be planted in fields where Austrian Winter peas or common vetch have given poor results as a result of disease damage.
5. When legumes are planted following cotton, leave the cotton stalks for the peas or vetch to grow on, unless the presence of old cotton stalks is objectionable.

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THE TOBACCO THRIPS

Its Seasonal History and Status As a Cotton Pest

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THE TOBACCO THRIPS

Its Seasonal History and Status As a Cotton Pest

L. D. Newsom, J. S. Roussel and C. E. Smith

INTRODUCTION

Thrips have been recognized as pests of seedling cotton in the United States for more than twenty years. The amount of damage caused by these insects has been highly controversial. Most of the studies published on the effect of thrips infestation on yield have been based on comparisons of severely injured plants with adjacent uninjured plants. These studies have not taken into consideration the factor of competition between injured and uninjured plants and, therefore, are of questionable value. Development of new insecticides which are highly effective for control of thrips has made possible comparisons between treated and untreated plots, thereby eliminating competition as a factor.

Previous studies of the thrips problem on cotton generally have dealt with the effect on yield and maturity without regard to the effect on vegetative growth. The trend toward mechanization of cotton production, with increasing use of post-emergent herbicides and flame cultivation for weed control and use of mechanical pickers for harvesting the crop, has made desirable the early uniform growth of seedling plants.

Review of published information revealed a need for more information on the importance of thrips as pests of cotton. The studies reported here were designed to furnish information on the following points:

1. Effect of injury on vegetative growth, maturity, and yield;
2. Species of thrips responsible for injury;
3. Seasonal history for information to form the basis for timing insecticide applications;
4. Host plants which allow for the build-up of populations;
5. Possibility of resistance to thrips injury among the more commonly planted commercial varieties.

Review of Literature

Wardle and Simpson (1927) made a study of *Thrips tabaci* Lind. under greenhouse conditions in England. They reported that hairy American and Indian varieties of cotton were more heavily attacked than the smoother leaved Egyptian varieties. Eddy and Clarke (1930) first called attention to thrips as pests of cotton in the United States by pointing out that infestation by the onion thrips, *Thrips tabaci* Lind., caused seedling cotton plants to grow slowly and assume a malformed condition. Eddy and Livingstone (1931) reported on the tobacco thrips, *Frankliniella fusca* (Hinds), as a pest of seedling cotton in South Carolina. Their experiments led them to conclude that *F. fusca* malforms seedling plants and retards growth. They reported grasses, cotton, and onions as being the principal hosts in the vicinity of Clemson College, with tobacco a major host in tobacco growing sections. Their studies indicated that this species overwintered as an adult female in and around roots, or at the base of host plants such as crabgrass, broomsedge, and Bermuda grass under conditions of severe weather; in places with mild winters they were found to overwinter on oats, evening primrose, and other unspecified green plants. They found no evidence that the males were able to hibernate successfully.

Gaines (1934) reported on a preliminary study of thrips on seedling cotton made in the vicinity of College Station, Texas, and stated that thrips were usually present on seedling cotton in fairly large numbers every year and apparently caused considerable injury. He reported the most common species to be *Frankliniella tritici* (Fitch) and *Sericothrips variablis* (Beach), with *F. fusca* present in small numbers. The effect of thrips injury was studied by tagging injured plants the first of May for observation later in the season. These plants were characterized later by the occurrence of two or more main branches and sometimes by excessive vegetative branching. When such injured plants were compared with normal plants occurring consecutively down a row in which 35 per cent were classified as injured and 65 per cent as uninjured, the injured plants produced 56 per cent less bolls and set bolls at least two weeks later than the normal plants.

Watts (1936) reported *F. tritici* as probably being the most destructive of 11 species occurring on cotton in South Carolina, with damage being serious in certain areas at irregular intervals. *F. fusca* was considered to be of less importance. He reported thrips injury to be negligible after the cotton had reached the age of about six weeks, with injury never observed after the beginning of squaring. Watts (1937) studied the effect of thrips injury on yield by comparing plants injured so severely that the terminal bud was killed, resulting in growth of two or more main stems instead of one, with the nearest adjacent plants showing little or no injury. Using this basis of comparison he concluded that 56 per cent of the plants in a five-and-one-half acre field would have produced approximately 40 per cent more cotton in the absence of thrips injury.

Dunnam and Clark (1937), using a method similar to those reported by Gaines (1934) and Watts (1937), studied the effect of thrips infestation on 40 varieties of cotton at Stoneville, Mississippi. They found that there was a reduction of 13.38 per cent in yield of seed cotton and that boll set was delayed 10 days to two weeks on the injured plants. No difference in varietal susceptibility was observed.

Watts (1937) listed 13 species of thrips occurring on cotton in South Carolina. Of these he considered the following four responsible for appreciable injury to cotton at irregular intervals: *F. tritici, F. fusca, T. tabaci,* and *S. variabilis.* He considered *F. tritici* to be the most important with *F. fusca* second in importance as a pest of cotton.

Sharp and Eddy (1938) reported that *F. fusca* was responsible for most of the thrips injury to cotton in Louisiana.

Bailey (1938) listed *F. occidentalis* (Perg.) and *F. moultoni* (Hood) as being responsible for injury to seedling cotton in California causing ragging, crinkling, and cupping of the leaves with temporary stunting from which the plants rapidly recovered after the onset of hot weather.

Fletcher and Gaines (1939) reported the results of a survey of thrips injury in 12 bottom land and two upland fields at College Station, Texas. They concluded that yield was reduced by an estimated average of 107 pounds of seed cotton per acre with a delay of 10 days to two weeks in boll production.

Smith (1942) reported that injury to seedling cotton by *F. occidentalis* was responsible for the production of 15-25 per cent bushy plants in the San Joaquin Valley of California. Such plants were said to bloom about two weeks later but could eventually produce as many bolls as comparable uninjured plants. Bolls produced on bushy plants were lighter, smaller, later, and occurred more frequently as four-lock bolls.

Fletcher *et al.* (1947) first reported results of experimental work in which thrips were controlled by use of DDT and BHC, allowing comparisons between plots treated for thrips control and those untreated. In tests conducted at College Station and Terrell, *F. tritici* was the most abundant species at both locations. In three tests conducted in 1946 applications of a 5 per cent DDT-sulphur mixture resulted in an average of 47.6 per cent control compared to the untreated check but failed to reduce the percentage of "thrips-injured" plants or to increase yields. The authors suggested the probability that factors other than thrips were responsible for the "so-called 'thrips-injured' plants." Gaines *et al.* (1948) reported two additional experiments conducted near College Station, Texas, during 1947 in one of which the percentage of "thrips-injured" plants was reduced but yield was not increased, and in the other neither percentage of "thrips-injured" plants nor yield was affected. Again the probability of other factors being responsible for injury attributed to thrips was suggested.

Biology of the tobacco thrips has been investigated by Eddy and Livingstone (1931), Watts (1936), and Burns (1951). These studies show that development from egg to adult requires about two weeks under laboratory conditions, that brachypterous and macropterous forms of both sexes occur, and that females are produced from fertilized eggs while only males are produced from unfertilized eggs. Different forms of both sexes are shown in Figure 1.

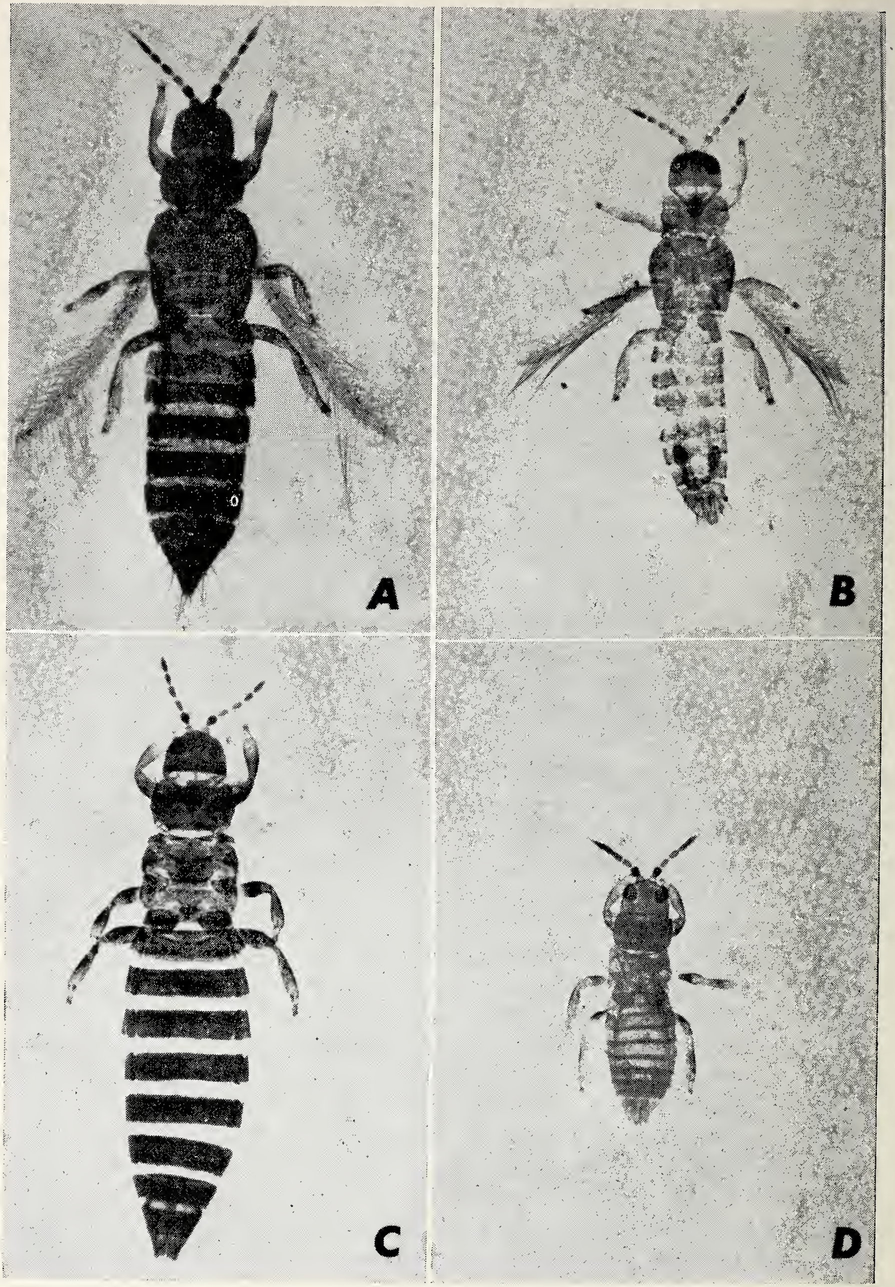

FIGURE 1.—Different forms of the tobacco thrips. *A*. Macropterous female; *B*. macropterous male; *C*. brachypterous female; *D*. brachypterous male.

SEASONAL HISTORY

Host Plants

Beginning in March, 1949, and continuing through 1952 a study was made in Louisiana to determine the host plants responsible for the early spring build-up of large populations of the tobacco thrips. Plants considered to be possible hosts were swept with a sweeping net 12 inches in diameter. Usually 25 sweeps were made at each location. All material swept into the net was transferred to pint-sized ice cream cartons for transportation to the laboratory. In the laboratory the material collected in the sweepings was emptied on a sheet of white paper and the thrips collected by means of an aspirator. They were then transferred to vials containing 70 per cent alcohol, labeled with collection data, and examined when convenient under a binocular microscope. Where hosts were not adaptable for sweeping, e.g., seedling corn and cowpeas, the plants were collected by hand and handled in the same manner as sweepings collected by use of the net. Collections were made from various host plants over the entire state.

Results—The tobacco thrips was found capable of reproducing and establishing heavy populations on a wide range of important crop plants. Among the more important were the clovers and alfalfa. Large populations were found to develop during late winter and early spring months on white clover, bur clover, crimson clover, Persian clover, hop clover, and alfalfa. During late spring when the clovers began to mature, macropterous forms were found to transfer to other hosts such as oats, seedling corn, and cowpeas.

Important summer host plants were found to be alfalfa and lespedeza. Collections were also made from soybean, cowpea, *Sorghum halepense, Leptochloa filiformis,* and *Brachiaria extensa.* An improved strain of white clover capable of producing some growth through the summer months at Baton Rouge was found to serve as a year-round host. Adults were collected each month of the year on this strain of clover and larvae were found in every month except November. Data from host plant studies are summarized in Tables 1, 2, and 3.

TABLE 1. Average number of adult and larval tobacco thrips per 25 sweeps of the most important winter and early spring hosts for the period 1949-1952

Month	White clover	Alfalfa	Crimson clover	Bur clover	Oats
January	88.4	....	....	233.5	26.0
February	149.4	....	....	223.5	44.0
March	103.8	78.0	36.4	126.5	8.7
April	89.2	62.5	25.6	78.6	24.6
May	48.6	171.0	....	6.0	156.7
June	62.9	41.7	....	....	....
July	....	....	....	....	....
August	....	42.5	....	....	....
September	....	....	....	....	....
October	....	....	....	....	7.0
November	....	....	....	....	....
December	....	....	....	....	....

TABLE 2. Average number of adult and larval tobacco thrips per 25 sweeps of other host plants

Host	Number Collected	Host	Number Collected
Medicago arabica	22.0	Lathyrus hirsutum	7.0
Vicia villosa	3.0	Brachiaria extensa	26.0
Ladino clover	21.0	Lespedeza striata	46.0
Trifolium pratense	2.5	Seedling corn*	41.0
Trifolium procumbens	34.0	Seedling cowpea*	22.0
Medicago lupulina	117.0	Seedling watermelon*	323.0
Trifolium resupinatum	64.0	Seedling cantaloupe*	114.0

*Counts based on the number of adults and larvae threshed from 25 plant samples.

TABLE 3. Seasonal development of different forms of the tobacco thrips on white clover at Baton Rouge, Louisiana, during the period September, 1950, to August, 1951

Month	Number per 25 sweeps		
	Adults		Larvae
	Macropterous	Brachypterous	
September	18.0	3.5	2.0
October	3.8	5.5	3.0
November	0.7	5.7	0.0
December	0.2	15.4	1.6
January	0.0	34.5	15.8
February	0.5	86.2	13.8
March	63.0	203.0	69.8
April	63.0	178.2	26.5
May	30.0	21.2	3.2
June	72.8	41.5	0.5
July	61.4	72.4	4.2
August*	8.0	22.0	0.0

*Application of 10 per cent DDT made to clover planting August 6, 1951.

TABLE 4. Development of macropterous tobacco thrips at Baton Rouge, Louisiana

Month	Number per 25 sweeps					
	White clover			Bur clover		
	Macropterous	Brachypterous	Percentage Macropterous	Macropterous	Brachypterous	Percentage Macropterous
			1949			
March	10.5	55.2	16	33.0	43.0	43
April	9.5	3.5	73	7.0	1.0	88
May	4.0	0.0	100	2.0	0.0	100
			1952			
January	3.0	362.0	1	3.0	273.0	1
February	5.0	259.0	2	17.0	198.0	8
March	22.0	243.0	16	16.0	36.0	30
April	239.0	97.0	70	119.0	8.0	92
May	5.0	0.0	100	89.0	5.0	95

During the course of studies of host plants it was observed that practically all of the adult thrips collected during January and a high percentage of those collected in February were of the brachypterous form. Beginning in March the proportion of macropterous forms began to increase sharply and the ratio between the two forms gradually reversed. Table 4 presents data showing this development on white clover and bur clover at Baton Rouge during the years 1949 and 1952.

Dispersion

Dispersion of the tobacco thrips was studied at Baton Rouge during the period 1949-1952. In general these studies were made by trapping the flying insects on surfaces coated with tree tanglefoot. In 1949 the tanglefoot traps consisted of 3 by 5 filing cards coated on one side with a thin layer of tanglefoot and attached to a hardware cloth screen constructed so as to present a vertical trapping surface exposed to each major point of the compass. A total of 36 cards was used with 9 facing in each direction. These traps were placed at elevations of 3, 4, and 5 feet above the soil. Of these, three were located at each elevation for each cardinal direction. Traps were operated during the period March 8 to May 8. Only female thrips were recorded in 1949.

A series of tanglefoot traps were in continuous operation at Baton Rouge from April 22, 1950, until December 31, 1952. These traps consisted of aluminum alloy plates five and one-half by eight inches bolted to wooden stakes for support. The effective trapping surface consisted of an area five by six inches. Ten of these traps were arranged so that the trapping surface was at an angle of approximately 45 degrees to the soil surface. The trapping surface was exposed toward the south. Traps were located in a cotton field planted to a cover crop of hairy vetch during the winter months. The height of the traps from the soil was adjusted periodically to keep the trapping surfaces just above the tops of the growing cotton plants. Old tanglefoot was scraped off and fresh material applied at weekly intervals.

Traps were examined daily, thrips removed with a scalpel or knife blade, placed on a sheet of ruled paper numbered to correspond to the trap number, brought into the laboratory, and examined under a binocular microscope. Both male and female thrips were recorded. Trapping records summarized by months are given in Table 5.

During a period of spring and summer of 1950 and 1951, six traps were operated in the same manner in a cotton field near Curtis, Louisiana. Six additional traps were operated at Homer, Louisiana, during 1951. These traps were examined at approximately weekly intervals. The results are recorded in Table 6.

Development on Cotton

Detailed studies of development of the tobacco thrips on seedling cotton in the field were made during 1950 and 1951. Twenty plants from each of five locations in each field where studies were made were pulled

TABLE. 5. Dispersion of the tobacco thrips at Baton Rouge, Louisiana, 1949-1952

Month	Number of adult tobacco thrips trapped per day per square foot of trap			
	1949	1950	1951	1952
January			0.00	0.60
February			0.09	0.17
March	0.92		1.90	0.76
April	1.13		7.11	2.09
May	0.97	11.32	8.37	4.36
June		1.20	8.22	3.10
July		0.48	2.09	0.65
August		0.17	0.43	0.08
September		0.17	0.08	0.00
October		0.22	0.06	0.05
November		0.11	0.10	0.02
December		0.02	0.19	0.02

TABLE 6. Dispersion of the tobacco thrips in cotton fields

Month	Number of adult tobacco thrips trapped per day per square foot of trap		
	Curtis, Louisiana 1950	Curtis, Louisiana 1951	Homer, Louisiana 1951
April	....	19.0	8.5
May	24.7	46.5	15.2
June	3.2	30.6	0.7
July	3.7	5.0	0.3
August	0.5	....	....
September	0.3	....	....

from the soil and threshed over a "thrips-catcher." This "thrips-catcher" was a modification of that described by McGregor (1941) and consisted of a box 3 x 5½ x 6 inches in size covered with 16-mesh wire screen. A slit cut in one end of the box allowed for the insertion of an aluminum alloy plate coated with tanglefoot. The trapping surfaces of these plates were marked with lines spaced one-half inch apart for convenience of examination under the binocular microscope. Both adults and larvae were easily dislodged from the plants in this manner and collected on the tanglefoot coated plates.

Collections were begun soon after plants had emerged to a stand and were continued at intervals of approximately one week for four to eight weeks. The numbers of adult *F. fusca, F. tritici,* and larval thrips were recorded. Typical examples of development on cotton during the years 1950 and 1951 are given in Table 7 and depicted graphically in Figure 2.

DISCUSSION

As can be seen from an examination of Tables 1, 2, and 3, the tobacco thrips may develop large populations on a number of different plants during the late winter and early spring months. Among the more important of these hosts, both from the standpoint of suitability for thrips development and acreage grown, are white clover, *Trifolium repens* L.,

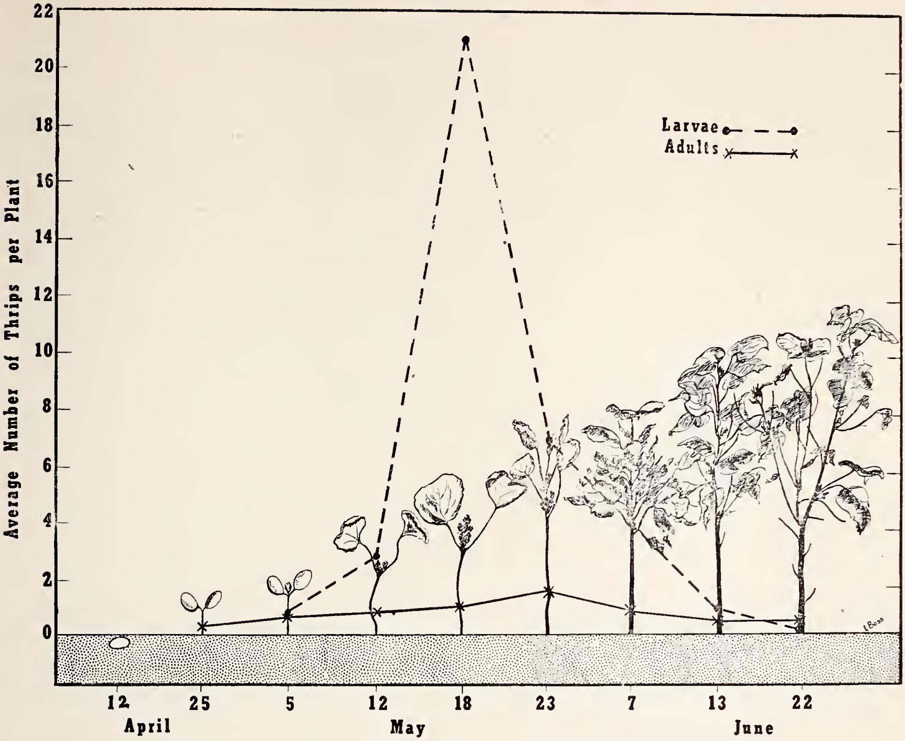

FIGURE 2.—Seasonal history of the tobacco thrips on cotton in Louisiana.

TABLE 7. Typical examples of development of the tobacco thrips on seedling cotton during 1950 and 1951

Date examined	Number per 100 plants		
	F. fusca	*F. tritici*	Larvae
	Benton, Louisiana, 1950. Cotton planted April 12		
April 25	24	3	0
May 5	69	1	79
May 12	91	1	279
May 18	98	3	2094
May 23	160	1	707
June 7	94	1	401
June 13	74	7	101
June 22	48	8	26
	Benton, Louisiana, 1951. Cotton planted April 24		
May 10	5	0	0
May 18	29	0	227
May 24	95	5	437
May 31	186	1	334

crimson clover, *T. incarnatum* L., alfalfa, *Medicago sativa* L., bur clover, *M. hispida* Gaertn., and oats, *Avena sativa* L. With the exception of alfalfa these hosts usually have matured or are beginning to mature during the period when cotton is in the seedling stage and susceptible to injury by the tobacco thrips. Maturity of its late winter and early spring hosts forces the insect to move from these plants and to seek a more desirable host. Seedling cotton is an ideal host at this time of year.

It is possible that the trend toward increased livestock production during the last decade with its consequent emphasis on improvement of pastures and growing of more feed crops by increased planting of the crops mentioned above may result in greater populations of the tobacco thrips. Not enough information is available to evaluate the effect of this change in cropping practices upon tobacco thrips populations. The growing of more winter and early spring crops which are suitable hosts for this species may result in more serious damage to seedling cotton than is the case at present.

Austrian winter pea, *Pisum arvense* Poir., common vetch, *Vicia sativa* L., hairy vetch, *V. villosa* Roth, and sour clover, *Melilotus indica* (L.), commonly grown as winter cover crops in the cotton growing areas of Louisiana were found to be of no importance as hosts of the tobacco thrips. Occasionally a few adults were found on these plants but larvae were never taken from them.

Important summer hosts among cultivated crops were alfalfa and lespedeza, *Lespedeza striata* (Thumb.) H & A. These crops like the clovers are being grown more extensively in connection with increased feed production in Louisiana. They contribute toward maintaining relatively high populations of the tobacco thrips during a time of year which is adverse for its development. Alfalfa is the only crop plant observed to furnish a satisfactory food supply for the development of tobacco thrips throughout the year. However, an improved strain of white clover being grown at Baton Rouge produced enough growth to allow for continuous thrips development during the period September, 1950, to August, 1951. Data presented in Table 3 show that larvae were present on this crop each month of the year except November.

A careful study to determine the wild host plants of the tobacco thrips was not made. However, *Brachiaria extensa* Chase, a grass often found growing in and adjacent to cotton fields, was observed to be an important summer host. Johnson grass, *Sorghum halepense* (L.), and red sprangletop, *Leptochloa filiformis* (Lam.), were other hosts found in or near cotton fields.

Data in Tables 1 and 2 show that the tobacco thrips may develop on a wide range of host plants which grow at different seasons of the year.

As previously stated the tobacco thrips was found to breed continuously throughout the year in Louisiana. These findings do not agree with those reported by Eddy and Livingstone (1931), who found that this species apparently passed the winter as the adult female at Clemson, South Carolina. In these studies it was found that the brachypterous form of the tobacco thrips was active throughout the winter months in Louisiana and developed heavy populations on various hosts. Beginning in March there was a gradual change to the macropterous form, and by May most of the adults were long-winged.

The factors responsible for this change in wing form are not understood. Eddy and Livingstone (1931) did not consider seasonal variations responsible for this phenomenon.

Tables 3 and 4 show a gradual change from the brachypterous to the macropterous form as the season progresses. These data show conclusively that the factors responsible for the change in wing form are seasonal in nature. They strongly suggest that changes in photoperiod or temperature, or both, may be directly responsible in their effect on the insect or indirectly responsible in their effect on the host plant.

As expected, dispersion of the tobacco thrips reached a peak during the spring months which coincided with the time at which the highest proportion of the population was macropterous. Data in Table 6 show that there was some dispersion of tobacco thrips throughout the year at Baton Rouge. Dispersion studies reported for 1949 are not comparable to those for the following years. Data for 1949 were obtained from an equal number of traps placed to face toward the four cardinal points of the compass. The majority of the thrips taken during this year were from traps facing toward the south. Comparatively few thrips were taken on the traps facing toward the other directions. In succeeding years all traps were set up to expose the trapping surface toward the south. Since the prevailing winds are from the south it seems probable that this is the major factor affecting the direction of flight.

Dispersion studies in northwest Louisiana during 1950 and 1951 gave results similar to those at Baton Rouge. As at Baton Rouge, dispersion reached its peak during May and tremendous numbers of tobacco thrips were moving into cotton at a time when it was most susceptible to attack. For example, at Curtis, Louisiana, in 1951 the tobacco thrips was trapped at the rate of more than two million per acre per day throughout the month of May.

Studies of development on cotton showed that seedling cotton is usually attacked by the adult tobacco thrips as soon as it breaks through the soil, and one or two generations develop during the following month to six weeks before the insects leave the cotton. Maximum populations usually develop approximately one month after the seedling plants have emerged from the soil. Injury is most noticeable at this time.

Although the flower thrips, *F. tritici,* is the species which has most often been reported as being responsible for damage to seedling cotton in the South (Gaines, 1934; Watts, 1936), it was of no importance in Louisiana during the period covered by these studies. This is in agreement with the report by Sharp and Eddy (1938) which stated that the tobacco thrips was responsible for most of the thrips injury in Louisiana. Data in Table 5 show that only three per cent of the total adult population taken from cotton was *F. tritici*. This species often develops heavy populations in the flowers of cotton. The onion thrips, *Thrips tabaci*, made up such a small percentage of the total population on cotton that it was not considered of sufficient importance to justify inclusion in this study. Therefore it is considered that the tobacco thrips, *F. fusca*, is the species responsible for thrips damage to seedling cotton in Louisiana.

EFFECT ON GROWTH AND YIELD

Injury to seedling cotton by the tobacco thrips is caused by the feeding of both adults and larvae. The adults attack the plants as soon as they emerge from the soil. They feed and deposit eggs in the cotyledons and leaves. Heavy feeding on the cotyledons results in their taking on a silvery appearance. The larvae attack cotyledons, leaves, and buds. Destruction of leaf tissue in the bud stage results in ragged, crinkled leaves. Since both larvae and adults feed inside the bud and therefore on its upper surface, injured leaves curl upward instead of downward as is the case with aphid injury.

Where the infestation is severe, buds may be killed outright. Plants injured in this manner often look as though they had been scorched by fire. When the terminal bud is killed, apical dominance is lost, new buds develop, and the plant becomes excessively branched and distorted

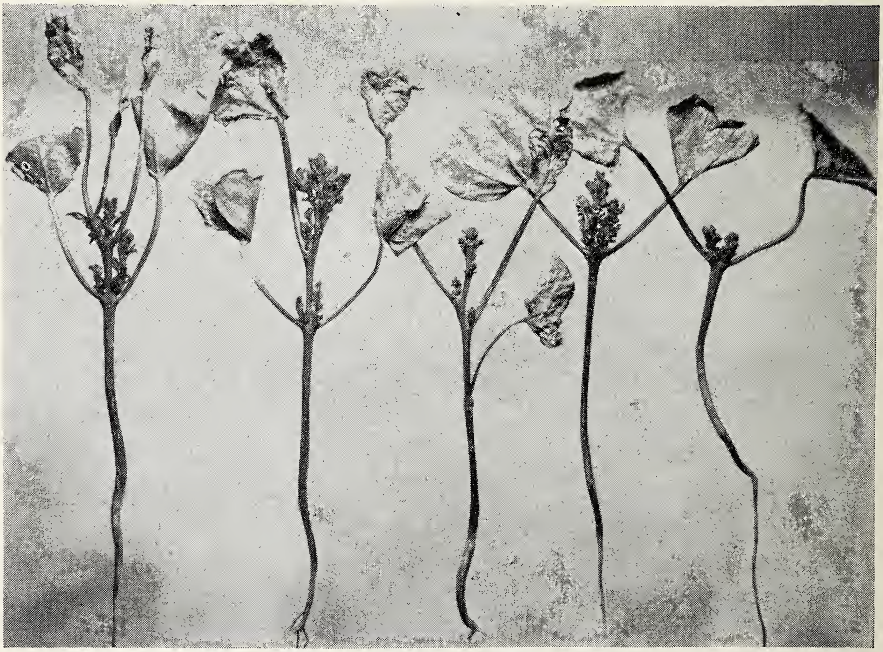

Figure 3.—Seedling cotton plants showing severe injury by the tobacco thrips.

in appearance. Examples of thrips injury are shown in Figure 3. Comparisons between treated and untreated plants are given in Figure 4.

The tobacco thrips usually leaves cotton after the plants are four to six weeks old and recovery is rapid.

The effects of thrips injury to cotton in the seedling stage upon subsequent vegetative growth and yield were studied in small and large plot tests at several locations during the years 1949, 1950, and 1951. At the same time the possibility of differences in susceptibility of the more commonly grown varieties was investigated.

Small Plot Tests

The following five varieties of upland cotton were studied in small plot tests during each of these years: Deltapine 15, Coker 100 Wilt, Stoneville 2 B, Delfos 9169, and Empire. Louisiana 33 was included in the tests during 1949 but was replaced by Fox in 1950 and 1951. Practically the entire acreage in Louisiana is planted to these varieties, with Deltapine 15 comprising about 85 per cent of the total acreage.

During this three-year period, tests were conducted at St. Joseph, Calhoun, Homer, and Shreveport. These locations gave a wide variety of soil types as well as other ecological differences.

The small plot tests were set up in a split-plot randomized block design with sub-unit treatments applied in strips across the blocks as described by Cochran and Cox (1950) to provide higher efficiency for study of interactions. Plots were usually 100 feet long and consisted of one variety planted in a single row. Each experiment consisted of six varieties usually replicated 10 times. Thrips were controlled on one-half of each plot while the remaining half served as an untreated check. Uniform treatments for the control of other pests later in the season were made to the entire experiment. Insecticides used for thrips control were applied as sprays in order to decrease the possibility of drift from treated to untreated plots. Sprays were formulated from emulsifiable concentrates or wettable powders. The first application of insecticide was made as soon as the plants had emerged to a stand. Subsequent applications were made at intervals of approximately one week for a total of two or three applications. A spray formulated from a 50 per cent DDT wettable powder concentrate applied at the rate of 0.25 pound per acre was used in 1949. A spray prepared from emulsifiable concentrates of toxaphene applied at the rate of one pound per acre was used in 1950 and 1951. All applications were made with a small, compressed air sprayer.

Thrips populations were sampled in 1949 by selecting 10 plants at random from each plot. The plants were placed in a paper bag for transportation to the laboratory, where they were threshed through a coarse wire screen on a black-topped table. Thrips dislodged from the plants in this manner were separated into larval and adult forms for counting and recording. For the experiments conducted in 1950 and 1951 the same technique was used as that described in the section on thrips development on cotton.

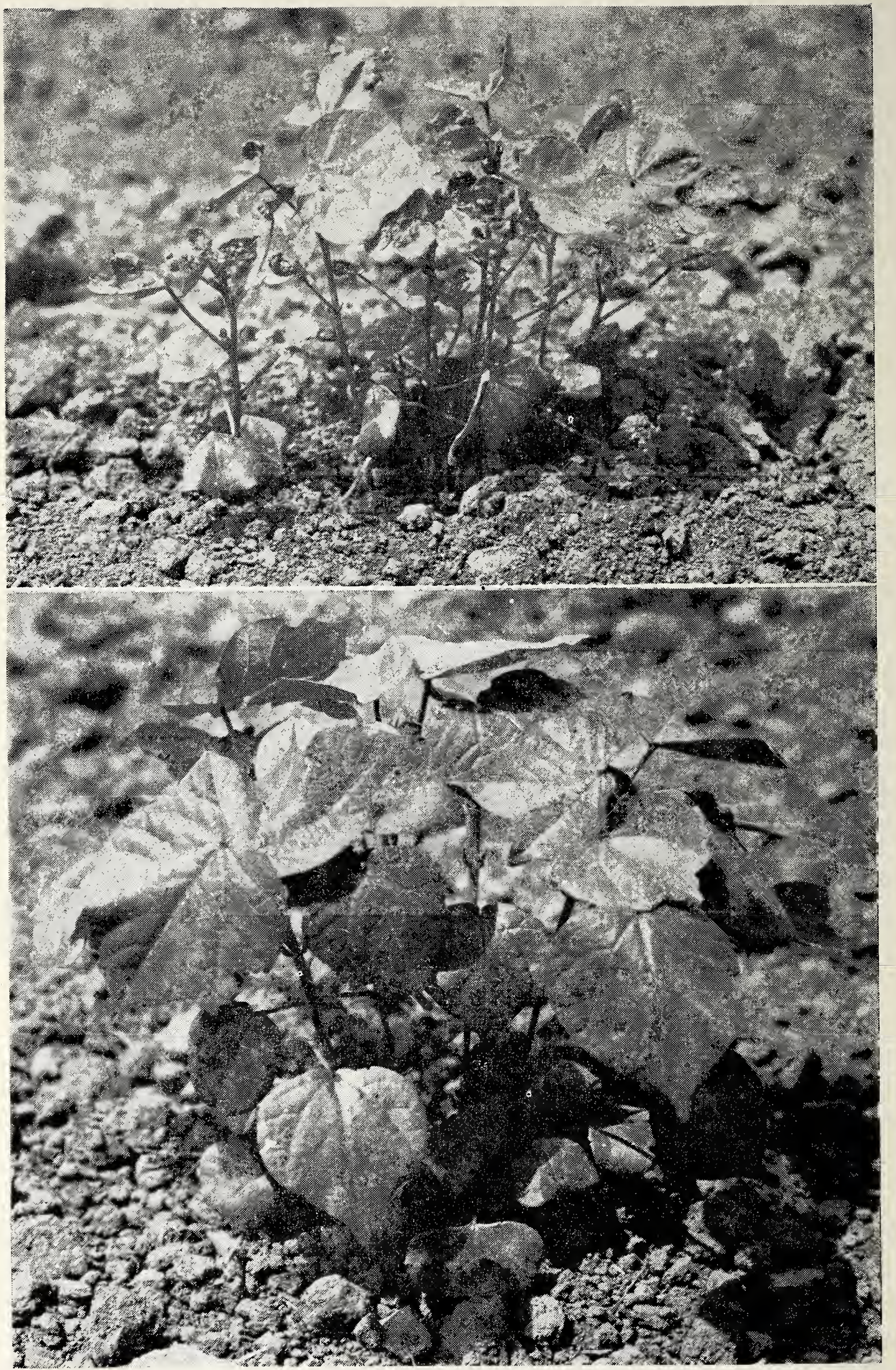

FIGURE 4.—Comparison between plants injured by tobacco thrips (top photo) and uninjured plants (bottom photo).

The criterion used to evaluate the effect of thrips injury on vegetative growth was height measurement of the main stem. Two measurements were made during the growing period. Each measurement was made on 25 consecutive plants in each plot beginning at a point selected at random. The first was made about six to eight weeks after emergence of the plants and the second when the plants had reached maturity. Height was taken from the soil line to the tip of the terminal bud and recorded to the nearest quarter inch. Degree of injury to the leaves was rated in the 1949 tests by visual inspection of 25 consecutive plants in each plot beginning at a point selected at random.

Plants were placed in one of the following classes according to the severity of injury:

0—no injury
1—injury to one true leaf
2—injury to two true leaves
3—injury to three true leaves
4—injury to four true leaves
5—injury to five true leaves
6—injury severe enough to cause abortion of the terminal bud

Injury indices were calculated according to the following formula:

$$\frac{\text{Summarization of class numbers}}{\text{Number of plants x number of injury classes}} \text{ x } 100$$

The effect on yield was measured by picking all of each subplot. An effort was made to take the first picking as soon as one-quarter to one-third of the total crop had opened. This was not always possible and in some cases all the cotton was allowed to open before a picking was made.

Results—Thrips populations were not determined in all tests. Treatments gave excellent control of the tobacco thrips. In tests where populations were determined, treated plants averaged less than 0.2 thrips per plant as compared to 13.9 for the untreated plants. Infestations during 1949 were heavier than in 1951. Counts presented do not necessarily represent the heaviest populations present in the tests during the season. In some cases counts were made either before or after peak populations had been reached. Severity of infestation varied between locations and from one year to the next at each location.

The five varieties planted each of the three years were all attacked with equal severity as indicated by population counts. Apparently the insect had no preference for any of these varieties. Counts are summarized in Tables 8, 9, and 10.

Growth measured by height of main stem at the date of first measurement was consistently depressed at all locations and during all years as a result of infestation by the tobacco thrips. Statistical analysis showed this difference to be highly significant. This effect was outgrown in all cases and when the second measurement was made differences in height

TABLE 8. Population counts. Average number of adult and larval thrips per plant. Homer, Louisiana, 1949 and 1951

Variety	Treated	Untreated
Empire	0.3	8.5
Deltapine 15	0.3	8.0
Coker 100 Wilt	0.4	8.7
Stoneville 2 B	0.3	12.4
Delfos 9169	0.3	8.2
Fox*	0.6	4.0
Louisiana 33**	0.1	16.8

*Fox counted only during 1951.
**Louisiana 33 counted only during 1949.

TABLE 9. Population counts. Average number of adult and larval thrips per plant. Calhoun, Louisiana, 1949

Variety	Treated	Untreated
Empire	0.1	22.9
Deltapine 15	0.1	17.0
Coker 100 Wilt	0.1	21.8
Stoneville 2 B	0.1	24.7
Delfos 9169	0.1	22.8
Louisiana 33	0.1	22.8

TABLE 10. Thrips counts. Average number of adult and larval thrips per plant. St. Joseph, Louisiana, 1949 and 1951

Variety	Treated	Untreated
Empire	0.2	10.8
Deltapine 15	0.1	12.9
Coker 100 Wilt	0.1	11.3
Stoneville 2 B	0.2	10.2
Delfos 9169	0.2	9.5
Fox*	0.2	2.5
Louisiana 33**	0.1	22.2

*Fox included in test in 1951.
**Louisiana 33 included in test in 1949.

TABLE 11. Height of main stem of cotton infested during the seedling stage by the tobacco thrips compared to that of plants treated for thrips control. Average for three seasons. Homer, Louisiana, 1949, 1950, and 1951

Variety	Measurement	Height in inches			Growth of main stem between first and second measurements	
		Treated	Untreated	Difference	Treated	Untreated
Empire	First	7.3	5.9	1.4		
	Second	28.3	27.5	0.8	21.0	21.6
Deltapine 15	First	6.6	5.1	1.5		
	Second	29.4	27.9	1.5	22.8	22.8
Coker 100 Wilt	First	7.4	6.0	1.4		
	Second	28.1	27.3	0.8	20.7	21.3
Stoneville 2 B	First	7.3	6.0	1.3		
	Second	28.0	27.1	0.9	20.7	21.1
Delfos 9169	First	7.0	5.5	1.5		
	Second	29.2	28.3	0.9	22.2	23.0
Fox*	First	6.8	5.6	1.2		
	Second	28.6	27.5	1.1	21.8	21.9
Louisiana 33**	First	7.1	5.4	1.7		
	Second	26.6	29.2	+2.6	19.5	23.8

*Fox included in tests during 1950 and 1951.
**Louisiana 33 included in test during 1949.

were no longer significant. Growth of main stem during the period between the first and second height measurements was practically identical. All varieties reacted in the same manner at all locations for all years. Data summarizing studies of the effect of tobacco thrips infestation on growth of the main stem of cotton are given in Tables 11, 12, 13, and 14.

TABLE 12. Height of main stem of cotton infested during the seedling stage by the tobacco thrips compared to that of plants treated for thrips control. Average for two seasons. Calhoun, Louisiana, 1949, 1951

Variety	Measurement	Height in inches			Growth of main stem between first and second measurements	
		Treated	Untreated	Difference	Treated	Untreated
Empire	First	7.3	6.4	0.9		
	Second	25.9	25.7	0.2	18.6	19.3
Deltapine 15	First	6.5	5.2	1.3		
	Second	27.0	25.5	1.5	20.5	20.3
Coker 100 Wilt	First	7.9	6.3	1.6		
	Second	27.1	26.9	0.2	19.2	20.6
Stoneville 2 B	First	8.2	6.7	1.5		
	Second	27.0	26.7	0.3	18.8	20.0
Delfos 9169	First	6.9	5.7	1.2		
	Second	27.2	26.1	1.1	20.3	20.8
Fox*	First	6.0	5.3	0.7		
	Second	22.4	23.0	+0.6	16.4	17.7
Louisiana 33**	First	9.0	7.3	1.7		
	Second	31.0	29.7	1.3	22.0	22.4

*Fox included in test during 1951.
**Louisiana 33 included in test during 1949.

TABLE 13. Height of main stem of cotton infested during the seedling stage by the tobacco thrips compared to that of plants treated for thrips control. Average for two seasons. Curtis, Louisiana, 1950, 1951

Variety	Measurement	Height in inches			Growth of main stem between first and second measurements	
		Treated	Untreated	Difference	Treated	Untreated
Empire	First	7.8	6.7	1.1		
	Second	39.0	37.9	1.1	31.2	31.2
Deltapine 15	First	6.7	5.8	0.9		
	Second	32.0	31.6	0.4	25.3	25.8
Coker 100 Wilt	First	8.1	6.7	1.4		
	Second	27.4	36.8	0.6	29.3	30.1
Stoneville 2 B	First	8.4	7.8	0.6		
	Second	36.2	35.3	0.9	27.8	27.4
Delfos 9169	First	7.5	6.3	1.2		
	Second	36.4	36.0	0.4	28.9	29.7
Fox	First	7.8	6.4	1.4		
	Second	35.2	33.1	2.1	27.4	26.7

TABLE 14. Height of main stem of cotton infested during the seedling stage by the tobacco thrips compared to that of plants treated for thrips control. Average for two seasons. St. Joseph, Louisiana, 1949, 1951

Variety	Measurement	Height in inches		
		Treated	Untreated	Difference
Empire	First	9.1	8.3	0.8
Deltapine 15	First	8.4	7.6	0.8
Coker 100 Wilt	First	8.6	8.0	0.6
Stoneville 2 B	First	9.4	8.7	0.7
Delfos 9169	First	9.4	8.5	0.9
Fox*	First	7.6	6.1	1.5
Louisiana 33**	First	11.7	11.1	0.6

*Fox included in test during 1951.

**Louisiana 33 included in test during 1949.

The effect of thrips infestation on growth of cotton as measured by severity of damage to leaves was studied at three locations during 1949. Injury indices computed showed that Empire was consistently less severely affected than the other varieties which were all damaged to the same degree at Homer and St. Joseph. At Calhoun, Empire was again less severely damaged than any of the other varieties. At this location Deltapine 15 was more severely damaged than any other variety included in the test. Data are summarized in Table 15.

TABLE 15. Varietal response of six varieties of upland cotton to thrips injury. Expressed as injury indices

Variety	Location			Average of all
	Homer	Calhoun	St. Joseph	locations
Empire	39.5	29.9	47.1	38.8
Deltapine 15	57.0	48.9	58.0	54.6
Coker 100 Wilt	54.0	37.5	58.7	50.1
Stoneville 2 B	51.9	40.0	61.1	51.0
Delfos 9169	49.7	37.2	57.5	48.1
Louisiana 33	52.3	36.9	61.1	50.1
L.D. 0.05	9.52	6.44	8.19	

Generally control of the tobacco thrips on seedling cotton resulted in earlier maturity for a portion of the crop. This was reflected in a slightly higher percentage of the total crop being harvested at the first picking. At Homer, treated cotton produced an average of about five per cent more of the total crop at first picking than untreated. Although highly significant, this difference is of little practical importance. All of the five varieties included in the three tests reacted in the same manner. Total yield was not affected by control of the tobacco thrips on seedling cotton. Data summarizing results of tests at Homer are given in Table 16.

At Curtis in 1950 control of the tobacco thrips on seedling cotton failed to affect maturity as measured by percentage of total crop harvested at the date of first picking. The 1951 test was picked only once, so effect of infestation on maturity was not observed in that test. Averages of the

TABLE 16. Effect of infestation by the tobacco thrips on yield. Average of tests at Homer, Louisiana, 1949, 1950, 1951

Variety	Picking	Yield in pounds seed cotton per acre			L.D. 0.05
		Treated	Untreated	Difference	
Empire	First	864	808	56	
	Total	1325	1376	+51	
Deltapine 15	First	604	519	85	
	Total	1174	1076	98	
Coker 100 Wilt	First	730	687	43	
	Total	1185	1203	+18	
Stoneville 2 B	First	739	705	34	
	Total	1234	1275	+41	
Delfos 9169	First	638	599	39	
	Total	1158	1217	+59	
Average for five varieties listed above	First	715	664	51	27.5
	Total	1215	1229	+14	
Fox*	First	771	756	15	
	Total	1038	1015	23	
Louisiana 33**	First	523	458	65	
	Total	1674	1693	+19	

*Fox included in tests in 1950 and 1951.
**Louisiana 33 included in test in 1949.

total yields obtained in both tests showed that thrips control did not produce any significant effects on yield. All of the six varieties included in these tests reacted in the same manner. Data obtained in the two tests are summarized in Table 17.

TABLE 17. Effect of infestation by the tobacco thrips on yield. Average of tests at Curtis, Louisiana, 1950, 1951

Variety	Picking	Yield in pounds of seed cotton per acre		
		Treated	Untreated	Difference
Empire	First*	1062	918	144
	Total**	1705	1569	136
Deltapine 15	First*	1028	1074	+46
	Total**	1487	1476	11
Coker 100 Wilt	First*	1092	928	164
	Total**	1601	1536	65
Stoneville 2 B	First*	1104	1012	92
	Total**	1706	1564	142
Delfos 9169	First*	1058	826	232
	Total**	1626	1641	+15
Fox	First*	1374	1380	+ 6
	Total**	1813	1683	130

*For 1950 test only.
**Average of both 1950 and 1951 tests.

The effect of thrips infestation on maturity was not studied in the tests conducted at St. Joseph during 1949 and 1951. The total crop was harvested in one picking. Thrips control failed to influence yield at this location. Data are summarized in Table 18.

TABLE 18. Effect of infestation by the tobacco thrips on yield. Average of tests at St. Joseph, Louisiana, 1949, 1951

Variety	Picking*	Yield in pounds of seed cotton per acre		
		Treated	Untreated	Difference
Empire	Total	2334	2316	18
Deltapine 15	Total	2423	2413	10
Coker 100 Wilt	Total	2509	2428	81
Stoneville 2 B	Total	2522	2561	+39
Delfos 9169	Total	2691	2659	32
Fox**	Total	2864	2948	+84
Louisiana 33***	Total	1855	1875	+20

*Only one picking made each year.
**Fox planted in test in 1951 only.
***Louisiana 33 planted in test in 1949 only.

In two tests conducted at Calhoun control of the tobacco thrips resulted in significant increases in the amount of cotton harvested at first picking and in total yield. Treated plots yielded about 18 per cent more at first picking. Total yield was increased by 20 per cent. All varieties reacted in the same manner to thrips injury at this location. Data are presented in Table 19.

TABLE 19. Effect of infestation by the tobacco thrips on yield. Average of tests at Calhoun, Louisiana, 1949, 1951

Variety	Picking	Yield in pounds of seed cotton per acre			L.D. 0.05
		Treated	Untreated	Difference	
Empire	First	1200	1018	182	
	Total	1560	1403	157	
Deltapine 15	First	877	731	146	
	Total	1207	977	230	
Coker 100 Wilt	First	1158	973	185	
	Total	1483	1354	129	
Stoneville 2 B	First	1158	1019	139	
	Total	1542	1432	110	
Delfos 9169	First	1089	904	185	
	Total	1516	1313	203	
Average for five varieties listed above	First	1096	929	167	121
	Total	1562	1296	266	158
Fox*	First	526	561	+35	
	Total	1040	1029	11	
Louisiana 33**	First	1438	1231	207	
	Total	1734	1538	196	

*Fox included in test in 1951.
**Louisiana 33 included in test in 1949.

Large Plot Test

A large-scale test was set up at St. Joseph, Louisiana, in 1951 to study the effect of thrips infestation on yield and rate of maturity. Since pests other than thrips, especially boll weevil and the cotton fleahopper, may also affect early fruiting of cotton it was necessary to design a schedule of treatments which would allow for the separation of the effects of these pests from those caused by thrips.

Four schedules of insecticide applications were made to replicated plots of Deltapine 15 cotton planted May 11. Plots were 32 rows wide, of sufficient length to comprise about one acre each, and were arranged in four randomized blocks. Applications for control of thrips and overwintered boll weevils were made with a four-row, tractor-drawn sprayer. Subsequent applications were made by airplane.

One series of plots designated TER was treated for control of thrips, overwintered boll weevils, and late season boll weevils; the second series designated TR was treated for control of thrips and late season boll weevils; the third series designated ER was treated for control of overwintered boll weevils and late season boll weevils; and the fourth series designated R was treated for late season boll weevil control only. Plots designated TER and TR received three applications of toxaphene at weekly intervals at the rate of one pound per acre beginning May 21; those designated TER and ER received three applications of toxaphene at weekly intervals at the rate of two pounds per acre beginning June 18; all plots received six applications of toxaphene at five-day intervals at the rate of three pounds per acre beginning July 27.

Height of main stem was measured six weeks after the plants had emerged to a stand. Daily blossom counts were made beginning July 2 and continuing through August 20. Yield data were obtained by making seven pickings between August 21 and October 8. All records were taken on 25-foot sections of the four center rows of each plot.

Results—Thrips infestation counts were not made in this test. However, an infestation developed which was severe enough to cause a reduction of 20 per cent in height of untreated plants measured six weeks after emergence. The average height in inches of plants in the various series of treatments was as follows: TER—22.0; TR—20.3; ER—18.5; and R—17.1.

Blossoming began during the first week in July and plots treated for thrips control produced significantly more blossoms during the first three weeks than the untreated plots. After the third week the rate of blossoming in treated and untreated plots tended to equalize. During the period July 31 to August 20, plots which had not been treated for thrips control exceeded the treated plots in total number of blossoms produced. Blossom counts grouped by 10-day periods are given in Table 20.

The first picking was made August 21, comprising about 15 per cent of the total yield of plots treated for thrips control compared to about 6 per cent of the total yield of the untreated plots. This difference in the

TABLE 20. Effect of thrips infestation on fruiting of the cotton plant as measured by rate of blossoming. St. Joseph, Louisiana, 1951

	Cumulative number of blossoms produced per 100 feet of row				
Period	TER	TR	ER	R	L.D. 0 05
7/2-7/10	63	54	45	27	22.3
7/11-7/20	571	518	470	393	87.0
7/21-7/30	1318	1256	1191	1066	---- --
7/31-8/10	2063	2134	2258	2242	---- --
8/11-8/20	2146	2249	2568	2576	298

amount of total crop harvested was significant. There were no differences in the amount of total crop harvested on subsequent dates until the last two pickings when the plots which were not treated for thrips control produced significantly more than those where thrips were controlled. Cumulative percentages and yield in pounds of seed cotton per acre are given in Tables 21 and 22, respectively.

TABLE 21. Effect of thrips infestation on maturity. St. Joseph, Louisiana, 1951

	Cumulative percentage of total yield			
Dates picked	TER	TR	ER	R
8/21	17	13	7	5
9/4	52	42	36	33
9/11	78	73	63	58
9/18	88	84	80	77
9/24	95	92	90	88
10/2	99	99	98	98
10/8	100	100	100	100
Yield in pounds seed cotton per acre	2293	2437	2715	2816

TABLE 22. Effect of thrips infestation on maturity. St. Joseph, Louisiana, 1951

	Cumulative yield in pounds of seed cotton per acre				
Dates picked	TER	TR	ER	R	L.D. 0.05
8/21	340	317	190	141	116
9/4	1192	1024	977	929	-----
9/11	1789	1779	1710	1633	-----
9/18	2018	2047	2172	2168	-----
9/24	2178	2242	2444	2478	-----
10/2	2270	2412	2661	2750	316
10/8	2293	2437	2715	2816	321

Net Assimilation Rate Study

Since tests conducted in 1949 and 1950 showed that cotton plants injured by thrips usually recovered rapidly, made as much growth, and yielded as much as uninjured plants, it was thought desirable to measure the rate of growth and photosynthetic efficiency throughout the growing season in order to determine how much time was required for injured plants to recover.

British investigators studying the effect of various environmental factors on plant growth have used net assimilation rate as a tool (Blackman and Rutter, 1948; Watson, 1947). According to Blackman and

Rutter (1948) net assimilation rate may be defined as the amount of dry matter synthesized per unit area of leaf surface per unit of time. Values were determined according to the formula:

$$\frac{W_2 - W_1 \quad (\log_e A_2 - \log_e A_1)}{(A_2 - A_1) \quad (t_2 - t_1)}$$

where W_2 and W_1 are the final and initial weights,
t_2 and t_1 are the times of sampling, and
A_2 and A_1 are the leaf areas.

In 1951 a large-scale test was set up to determine the effect of infestation by the tobacco thrips on cotton as measured by net assimilation rate. The test consisted of paired plots 12 rows wide and of sufficient length to comprise about one and one-fifth acres each. One plot of each pair was treated for thrips control and the other was untreated. The test was replicated five times.

Deltapine 15 cotton was planted April 24 and emerged to a good stand by May 4. Treatments for thrips control consisted of one pound of toxaphene applied with a six-row, tractor-drawn sprayer at the rate of one gallon of spray mixture per acre. Applications of the insecticide were made May 5, May 12, and May 20. Other pests which developed later in the season were controlled by a schedule of insecticide applications applied by airplane to the entire test.

Thrips populations were determined by counting all thrips on 20 plants per plot by the "thrips-catcher" method previously described. Counts were made May 10, 18, 24, and 31. Twenty plants per plot were selected at random on the following dates for study of growth and development: June 1, 14, 28, July 12, 26, and August 16. Height of stem, leaf area, dry weight, number of squares, number of bolls, and number of open bolls were recorded.

Height of stem was measured in inches from the cotyledonary node to the terminal bud; leaf area was determined by making blueprints of all leaves and measuring their areas with a planimeter according to the method described by Kreusler (1877) and adapted for use on cotton as described by Crowther (1934) ; dry weight was determined by cutting the plants at the cotyledonary node and air-drying them in an unheated greenhouse for a period of three months; squares, bolls, and open bolls were recorded for each plant at each sampling date; yields were obtained by picking all of the two center rows of each plot; leaf area measurements and dry weight determinations were used in computing net assimilation rates according to the formula given above.

Results—Adult tobacco thrips appeared on the seedling plants as soon as they emerged, and by May 18 larvae were active on the plants. A moderate infestation persisted on the untreated plants throughout the month of May. The three applications of toxaphene gave excellent control. Population counts are given in Table 23.

TABLE 23. Comparison of thrips populations on treated and untreated plots. Benton, Louisiana, 1951

Date Examined		Total number per 100 plants					Average number adults and larvae, both species, per plant
		Frankliniella fusca			Frankliniella tritici		
		Males	Females	Larvae	Males	Females	
5/10	Treated	0	0	0	0	0	0.00*
	Untreated	0	5	0	0	0	0.05
5/18	Treated	0	1	1	0	0	0.02*
	Untreated	0	29	227	0	0	2.56
5/24	Treated	0	16	4	0	6	0.26*
	Untreated	11	84	437	0	5	5.37
5/31	Treated	4	62	7	0	1	0.74*
	Untreated	10	174	334	0	1	5.19

*Significant at 0.01 level.

Infestation resulted in a reduction in height of stem of about 23 per cent when the first measurements were made five weeks after planting. This reduction in height was gradually overcome by the untreated plants and by August 16 the difference was no longer significant. During the period June 1 to August 16 stems of infested and uninfested plants grew at the same rate and made the same amount of growth. Uniformity in height of infested plants was considerably less than that of the uninfested plants as expressed by the coefficient of variation. Results of height measurements are given in Table 24.

TABLE 24. Effect of thrips infestation on growth as measured by height of stem. Benton, Louisiana, 1951

Date Measured	Average height in inches of treated plants	Coefficient of variation	Average height in inches of untreated plants	Coefficient of variation	Per cent reduction in height
6/1	4.15	20.2	3.20	29.3	22.9**
6/14	9.12	17.8	7.18	25.2	21.3**
6/28	19.70	15.0	16.10	19.7	18.3**
7/12	29.83	16.6	25.72	16.4	13.8**
7/26	33.58	17.5	32.26	14.6	3.9*
8/16	35.64	17.7	34.26	20.2	3.9
Growth stem 6/1 to 8/16	31.49		31.06		

*Significant at 0.05 level.
**Significant at 0.01 level.

Leaf area of untreated plants was reduced 59 per cent compared to that of treated plants June 1. As in height of stem, this difference steadily declined and by July 26 untreated plants had slightly more leaf area than those treated. The effects of thrips injury on leaf area are illustrated in Figure 5. Results are summarized in Table 25.

The effect of infestation by the tobacco thrips on dry weight of plant followed about the same trend as that on leaf area. Untreated plants weighed 35 per cent less than treated plants June 1 but were 8 per cent heavier August 16. Results of air-dry weight determinations are summarized in Table 26.

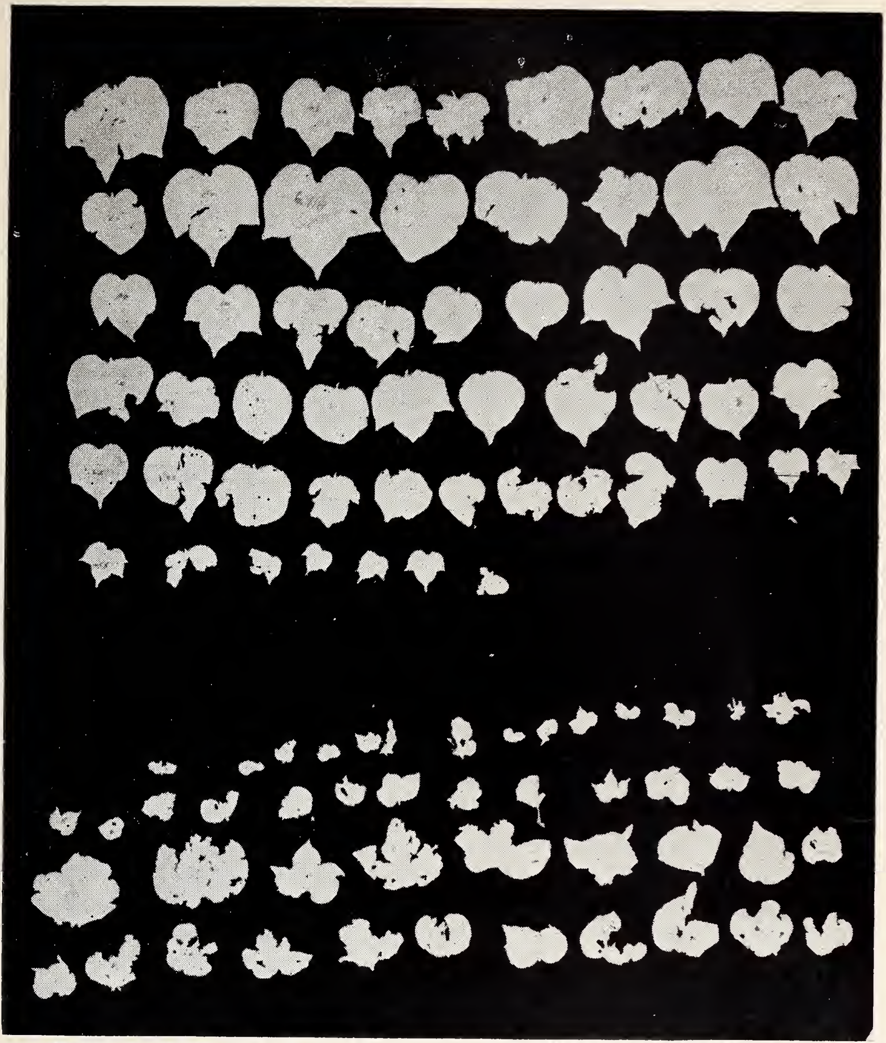

FIGURE 5.—Leaf area of ten plants treated for thrips control (above) and ten plants not treated (below).

TABLE 25. Effect of thrips infestation on growth as measured by leaf area and number of leaves. Benton, Louisiana, 1951

Date measured	Leaf area in square inches and number of leaves per plant				Per cent reduction	
	Treated		Untreated			
	Leaf area	No. of leaves	Leaf area	No. of leaves	Leaf area	No. of leaves
6/1	17.1	5.4	7.0	4.7	59*	13
6/14	77.9	13.5	51.6	12.1	34*	10
6/28	199.8	26.3	130.4	20.2	35*	23
7/12	487.6	42.4	373.8	33.2	23	22
7/26	610.7	53.6	629.7	56.7	+ 3	+ 5
8/16	375.6	36.2	378.4	41.0	+ 1	+12

*Significant at 0.01 level.

TABLE 26. Effect of thrips infestation on growth as measured by air-dry weight of plant. Benton, Louisiana, 1951

Date Measured	Air-dry weight per plant in grams Treated	Untreated	Per cent reduction
6/1	0.84**	0.55	35
6/14	3.88**	2.64	32
6/28	19.38*	13.17	32
7/12	46.46*	38.20	18
7/26	142.04	149.20	+ 5
8/16	81.96	88.63	+ 8

*Significant at 0.05 level.
**Significant at 0.01 level.

Fruiting, measured by counts of squares and bolls produced, showed an initial reduction resulting from infestation. However, as in the case of growth of stem and leaf area, infested plants outgrew the damage and by August 16 had produced more squares and bolls than the treated plants. Results are given in Table 27.

TABLE 27. The effect of thrips infestation on fruiting of the cotton plant as measured by production of squares and bolls

	Average number produced per plant					
	Squares			Bolls		
Date counted	Treated	Untreated	Per cent reduction	Treated	Untreated	Per cent reduction
6/1	0	0	---	0	0	---
6/14	1.3	1.0	23	0	0	---
6/28	7.8	6.6	15	0.05	0.01	80
7/12	18.2	17.0	7	2.69	2.53	6
7/26	13.5	12.3	9	8.10	8.22	+ 1
8/16	1.8	2.5	+28	7.89	8.95	+12

The effect of infestation on maturity in this test was negligible as shown by a count of open bolls made August 16 and the first picking made August 30 when about one-third of the total crop was picked. There were no significant differences in number of open bolls, yield at first picking, or final yield. Results are given in Table 28.

TABLE 28. Effect of thrips infestation on rate of maturity and yield. Benton, Louisiana, 1951

	Number bolls per plant		Yield in pounds of seed cotton per acre	
Date	Treated	Untreated	Treated	Untreated
8/16	0.7	0.7	------	------
8/30	-- --	-- --	427	447
9/20	-- --	-- --	1049	1016
Total	-- --	-- --	1476	1463

The net assimilation rate for untreated plants was significantly higher than for treated plants during the period June 1 to June 14. From June 15 to July 12 the net assimilation rate for untreated plants averaged slightly higher than that for the treated plants, but the difference was not significant. Results are given in Table 29.

TABLE 29. Effect of thrips infestation on growth of cotton as measured by net assimilation rate

Period	Grams dry matter produced per square inch of leaf area	
	Treated	Untreated
6/1-6/14	0.0383	0.0471*
6/15-6/28	0.0613	0.0623
6/29-7/12	0.0423	0.0561
Average during period 6/1-7/12	0.0473	0.0582*

*Significant at 0.05 level.

DISCUSSION OF RESULTS

Comparatively low rates of application of insecticides gave excellent control of the tobacco thrips on seedling cotton. For example, toxaphene at the rate of one pound per acre applied at intervals of one week for a total of two or three applications gave highly effective control. Cost of insecticide for controlling this pest may be considered negligible when compared to the total cost of a cotton insect control program.

One of the most important features of tobacco thrips control brought out by these studies was the necessity for making the first application as soon as cotton has emerged to a stand. Data in Figure 3 show the fallacy of waiting until the so-called four-leaf stage, as recommended in some areas, to make applications for thrips control when the species involved is the tobacco thrips. In cases of heavy infestations in Louisiana plants are unable to produce four leaves before severe damage has been produced. The fact that plants are attacked while so young and that applications of insecticides must be made immediately in order to prevent damage creates problems of practical importance. First, insecticides must be applied on a so-called "automatic schedule" without taking populations into consideration. This means that applications are often wasted since destructive populations do not always develop. In some years populations are prevented from reaching injurious levels through the detrimental effect of heavy rainfall. Secondly, there is some evidence, although not conclusive, that applications of insecticides for thrips control may have a destructive effect on predatory and parasitic insects resulting in the build-up of other injurious pests . For example, there has been a high correlation between the development of tobacco budworm and spider mite infestations and the use of early applications of insecticides.

All varieties included in this study seemed to be equally attractive to the tobacco thrips. Population counts did not differ on the various varieties.

Growth as expressed in height increase of the stem during the first six weeks after emergence was consistently and significantly reduced about 20 per cent as a result of infestation. This difference amounted to slightly more than an average of one inch per plant. Treated plants were not only a little more than one inch taller than untreated plants six weeks after emergence but were much more uniform in height. This slight difference in height is probably of little importance. However, the greater uniformity in height of treated plants may be of considerable value in cultivation practices. This is especially true where flame cultivation and post-emergent herbicides are used for weed control.

Frequently thrips injury to the terminal bud of seedling cotton results in its death and apical dominance of the stem is lost. As a result of this loss of apical dominance the plant may become excessively branched. Ballard (1951) states that such branches are often broken by implements, and plants excessively branched as a result of thrips injury may interfere with efficient operation of mechanical pickers. He offers no data in support of these statements.

Growth of the main stem from the time the plants were about six weeks old until they reached maturity was the same for untreated plants as for those on which thrips were controlled. All varieties studied reacted alike and there was never any significant difference between the height of treated and untreated plants at the end of the season.

Thrips injury caused a reduction in leaf area of all varieties during the first six weeks of growth. The difference in leaf area resulted from a reduction both in number and in size of leaves. In the 1949 tests when injury to the leaves was rated by visual inspection and expressed as an injury index, the variety Empire was significantly less affected than any of the other five varieties. This was true at all three locations where tests were conducted. At Calhoun, Deltapine 15 was affected more severely than any of the other varieties but this was not true at the other two locations. These results are in general agreement with those reported by Ballard (1951), who placed Empire in a group less severely damaged and Deltapine 15 in the severely damaged group of a number of varieties he studied for thrips resistance. His studies indicated that Coker 100 Wilt was of the same order of resistance as Empire, which was not the case in this study where it was significantly less resistant. Unfortunately his data do not indicate the species of thrips involved nor the degree of infestation existing in his tests.

Plant injury expressed as injury indices seemed to have little relation to subsequent development of the plant, and use of this method of rating injury was discontinued in subsequent tests. There seems to be little, if any, practical resistance to the tobacco thrips among the varieties studied.

Results from small plot tests at the two hill locations showed that thrips injury affected maturity to the extent that treated plots of Deltapine 15 produced an average of about 10 per cent more of the total crop at the date of first picking than untreated plots. On alluvial soil at Curtis, thrips injury had no effect on maturity of Deltapine 15 during the two years maturity was studied.

It is commonly recognized that early maturity of the cotton crop is desirable. This is especially the case where cotton is harvested mechanically. The effect on maturity as demonstrated in these tests, even at the hill locations where mechanical harvesting is not practiced, is of doubtful value.

Total yield was not affected by thrips injury except at the Calhoun station, where significant increases were obtained for all varieties. The average increase for all varieties resulting from thrips control during the two years the test was conducted there amounted to 266 pounds of seed cotton per acre. The yield of Deltapine 15 was increased by 230 pounds per acre. All varieties reacted in the same manner at this location. Most of the increase in yield occurred during 1949. In 1951 the average increase in yield resulting from thrips control at Calhoun amounted to about 8 per cent; the average increase for both years amounted to about 20 per cent.

Total yield was not significantly affected by thrips injury at the other three locations.

The majority of studies reporting on the effect of thrips injury on yield of cotton are open to serious criticism because the factor of plant competition has been disregarded. Most of the tests dealing with the effect of thrips infestation on yield have used the technique of comparing plants severely damaged by thrips injury with nearby plants which showed little or no effect of thrips infestation. For example, Watts (1937) compared severely injured plants with the closest plant having little or no injury. He did not take into consideration the fact that competition of the damaged plant with the uninjured plant for sunlight, water, and plant nutrients may have had more effect on yield than injury resulting from thrips infestation. The ability of cotton to compensate for various spacings in stands has been demonstrated by many investigators. Brown (1923) showed that little difference in yield results within wide spacing limits and Ware (1929) showed equal yields from stands ranging between 15,000 and 75,000 plants per acre. Pope (1947) concluded on the basis of 27 tests conducted during a 4-year period that skips in stands occurring on interior rows of multiple-row plots are largely compensated for by increased production on end plants in the row containing the skip and by lateral compensation on the adjacent rows. Plants which are stunted as a result of thrips injury are not able to compete on an equal basis with adjacent uninjured plants and therefore are unable to compensate for early stunting when yields are compared on an individual plant basis.

Gaines (1934) reported that thrips-injured plants, compared consecutively down the row with uninjured plants, produced 56 per cent less bolls, which were set at least two weeks later; Gaines and Fletcher (1939), again comparing injured and uninjured plants taken consecutively down a row, concluded that thrips injury was responsible for an estimated average decrease of 107 pounds of seed cotton per acre, with a delay of 10 days to 2 weeks in production of bolls by the injured plants. Where plots treated for thrips control were compared with untreated plots, Gaines *et al.* (1948) failed to obtain increases in yield from thrips control and suggested that other factors were responsible for this so-called thrips injury. In a study of dusting schedules on cotton yields, Gaines *et al.* (1948, a) obtained slight reductions in yield on plots which received dust treatments for thrips control at the time cotton was in the four- to eight-leaf stage and stated, "If cotton is forced to set fruit early, this tends to retard vegetative growth and apparently reduces the yield." Gaines *et al.* (1952) stated, "Planters have realized as indicated by their continued use of insecticides for thrips control that it is important to prevent damage from this pest."

As was the case in the small plot tests, thrips conrol in large-scale plots resulted in more vigorous vegetative growth during the first six weeks as measured by height of stem. The effect of infestation was extended into the first three weeks of fruiting, as was made evident by a significant reduction in number of blossoms produced during this period. However, plants in plots not treated for thrips control produced as many blossoms by the end of the fifth week of fruiting and produced significantly more blossoms by the end of the blossoming period. The effect on fruiting was reflected in maturity when 10 per cent more of the total crop was picked at the date of first picking in plots which were treated for thrips control. This difference was significant and amounted to 160 pounds of seed cotton per acre. Since only 15 per cent of the crop in plots treated for thrips control was mature at this time, the difference is of little practical value. Little harvesting is done when such a small percentage of the total crop is open, even with hand labor. It would be of no value where mechanical harvesters are employed. When about half of the total crop was open in plots treated for thrips control, there was no significant difference in the amount of cotton harvested from treated or untreated plots. By the end of the season, plots which were not treated had outyielded plots treated for thrips control by approximately one-quarter bale per acre. Obviously this difference in amount of cotton produced would outweigh benefits from the slightly earlier maturity of plants in treated plots.

When net assimilation rate was studied, infestation by the tobacco thrips was severe enough to cause 23 per cent reduction in height of stem, 59 per cent reduction in leaf area, and 35 per cent reduction in dry weight when measured five weeks after planting. As in other tests the infested plants gradually outgrew this injury and produced as much growth as uninfested plants.

Although the reduction in height of stem at five weeks after planting was 23 per cent, this actually amounted to a difference of only one inch between treated and untreated plants. Such a slight difference in height if the plants were all uniform is of doubtful value from the standpoint of cultivation. Height of untreated plants was much less uniform than was the case with treated plants. Data in Table 24 show that variability in height as expressed by the coefficient of variation was 20.2 for treated plants as compared to 29.3 for the untreated. This lack of uniformity in height has an adverse effect on the efficiency of cultivation practices. This is particularly true when applications of post-emergent herbicides and flame cultivation are used in the weed control program.

Differences in dry weight on a per plant basis were equalized during the period July 12-26. Effects of thrips infestation on growth as measured by dry weight showed the same trend as for height. By the last sampling date untreated plants had produced 8 per cent more dry matter than treated plants.

It would seem that scarred and distorted leaves of plants injured by thrips would be less efficient in synthesizing dry matter. When the efficiency of injured plants was compared to that of uninjured plants by measuring the net assimilation rate, it was found that the latter actually produced more dry matter per unit area of leaf surface. Injured plants were significantly more efficient when compared on this basis for the period June 1 to July 12. As Watson (1947) pointed out in his study of the effects of nutrient supply on net assimilation rate and leaf area, the effect on leaf area was much more important from the standpoint of dry matter produced than was net assimilation rate. For example, injured plants were 23 per cent more efficient than uninjured plants on the basis of dry matter synthesized per unit area of leaf during the period June 1-14, but the uninjured plants had 59 per cent more leaf area June 1 and 34 per cent more June 14. Therefore uninjured plants, although less efficient, were able to produce substantially more dry matter during this period than the injured plants.

Treated plants became senescent sooner than untreated plants. At the July 26 sampling date treated plants averaged 610.7 square inches of leaf area per plant compared to 629.7 square inches for untreated plants.

The effects of thrips infestation on fruiting as measured by production of squares and bolls showed the same trends as for vegetative growth. Maturity, as measured by the number of open bolls counted August 16, yield at the date of first harvest when about one-third of the total crop of bolls was open, and total yield, was not affected.

Thrips control on seedling cotton results in such striking improvement in appearance of plants during the first month to six weeks of growth that it is difficult to understand how comparable untreated plants can yield as well as or better than treated plants. The depressing effect of fruit set on subsequent vegetative growth of plants is a well-known phenomenon. Brown (1938) states, "Cotton growers often notice that when their plants become well loaded with fruit, vegetative growth is checked or even stopped almost altogether and that this stoppage of growth may occur when the plant is too small to bear many bolls." Eaton (1931) found that defloration of Acala upland and Pima Egyptian varieties for the first 25 days of blooming resulted in increased yields.

Thrips control allows relatively small plants to set fruit from the first forms produced provided overwintered boll weevils and fleahoppers are also controlled. Setting such fruit is an advantage from the standpoint of early maturity, but it has some disadvantages in addition to the possible depression of subsequent vegetative growth. Where mechanical pickers are used such bolls are often so low on the plant that they are missed. Bolls set low on the plant often rot, especially in years of high rainfall during harvest. These bolls frequently become stained and discolored from rain-splashed soil particles and when harvested have an adverse effect on grade. Such adverse effects resulting from setting early fruit tend to offset any advantages gained by earlier maturity.

SUMMARY

The tobacco thrips is the only thrips of any importance as a pest of seedling cotton in Louisiana. It is active throughout the year and develops heavy populations during the winter and early spring months on such crops as white clover, bur clover, crimson clover, and alfalfa. Occasionally large populations develop on oats, especially in the spring after some of the leguminous crops have become unattractive as a source of food and breeding material. Such crops as winter peas, common and hairy vetch, and sour clover which are commonly used as winter cover crops for cotton fields are of no importance in developing large populations of this species.

As the winter and early spring hosts mature the tobacco thrips is forced to seek a more desirable host. Dispersal activities are greatest at this time and reach a peak during May. Seedling cotton which becomes available at this time furnishes an ideal host. The seedling plants are attacked by the adults as soon as they emerge from the soil. The thrips feed and breed on cotton for the first month to six weeks of growth and then move to other hosts. Important summer hosts are alfalfa, lespedeza, and such wild grasses as *Leptochloa filiformis, Brachiaria extensa,* and *Sorghum halepense.*

The lowest point in the cycle of activity of this species occurs in the late summer and early fall months. As the clovers resume growth with the cool wet weather of late fall and early winter the activity of the insect accelerates.

Feeding of the adults and larval forms destroys leaf tissue in the bud stage and results in ragged, crinkled leaves. Severe infestations destroy leaf buds outright and the plants become excessively branched and distorted. Such injury may reduce the leaf area by 50 per cent or more when the plants are six weeks old. Height of injured plants at this age is usually reduced about 20 per cent and such plants are much less uniform in growth than comparable uninjured plants. Effects of such injury on vegetative growth is usually outgrown.

The effect of injury on vegetative growth is reflected in a slight delay in fruiting. Uninjured plants usually begin blossoming a few days sooner than injured plants. Injury also causes a slight delay in maturity of a small part of the crop. Yield was not affected at three of the four locations where these tests were conducted. At one hill location characterized by light, droughty soils, thrips injury caused a 20 per cent reduction in yield during the two years tests were conducted there.

Six varieties which are grown commercially in Louisiana reacted in a similar manner to thrips injury. All varieties were infested at the same levels. Visual inspection of plants for severity of injury during the seedling stage usually indicated that Deltapine 15 was more severely damaged and Empire less severely damaged than the other varieties. However, there was no difference in subsequent growth or yield.

Plants injured by thrips were more efficient in growth as measured by net assimilation rate studies, producing significantly more dry matter per unit area of leaf surface than comparable uninjured plants. This greater efficiency of the injured plants during the first 10 weeks of growth was overshadowed by the much greater amount of leaf area of uninjured plants.

Effective control of the tobacco thrips at low cost per acre was demonstrated with toxaphene and DDT applied as low-gallonage spray concentrates. Various other insecticides were equally effective. Correct timing of insecticide applications was found to be of prime importance in controlling this pest and preventing damage to the seedling plants. Two or three applications at one-week intervals, with the first made as soon as the plants had emerged to a stand, were found to be necessary for satisfactory control.

Results of these studies demonstrate that the only advantage to be gained from control of the tobacco thrips on seedling cotton is that of more uniform vigorous growth during the first month to six weeks. Effect of thrips injury on maturity is negligible, and untreated cotton often outyields treated cotton. Although not conclusively proved, there is strong evidence that applications of insecticides for thrips control have an adverse effect on populations of predaceous insects and result in subsequent heavy infestations of such pests as the cotton aphid, spider mites, and tobacco budworm.

Control of the tobacco thrips as a general practice in Louisiana is not recommended.

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The BROILER ENTERPRISE in Louisiana

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The Broiler Enterprise in Louisiana

EWELL P. ROY AND JAMES M. BAKER

INTRODUCTION

Production of broilers on a commercial scale is a relatively new industry in Louisiana. About 90 per cent of the estimated 400 houses in operation during 1951 were established since 1946. The growth has been more rapid and more concentrated in the hill-farming sections of northern Louisiana, where promotional methods were used to get the business started, than in the southern part of the state, where broilers have been produced principally for the local trade. Because of soil depletion and shortage of labor in some areas, broilers may replace cotton to a great extent as a primary source of cash income.

In every area of the state where broiler development is pronounced, the producers on the whole are new in the business and may need much assistance before becoming substantially established. Therefore, this study was designed to provide these producers, and the agencies working with them, information that will be helpful in the solution of some of the production and marketing problems.

Objectives

The study had four main objectives: (1) to delineate the economic characteristics of the broiler business in the state; (2) to analyze the physical aspects of broiler production and marketing equipment with respect to construction, costs, and operating efficiency; (3) to relate management and marketing practices to net returns to producers; and (4) to evaluate and define the information obtained in terms usable by those persons producing and marketing broilers.

Method of Study

To provide a comprehensive report on the broiler industry in Louisiana and to have the maximum amount of comparable data, the state was divided into three areas which were designated as the Ruston Area, the Northwest Area, and the Scattered Area, as shown in Figure 1. The Ruston Area comprises the parishes of Bienville, Claiborne, Jackson, Lincoln, Winn, and Union; the Northwest Area includes Bossier, Caddo, DeSoto, Natchitoches, Red River, and Sabine; and the Scattered Area covers the rest of the state. Data were obtained by the survey method using the sample technique in the Ruston and Northwest areas and contact with all known broiler producers in the Scattered Area.

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*This study is contributive to regional poultry and egg marketing research being conducted co-ordinately by Arkansas, Alabama, Georgia, Louisiana, Mississippi, South Carolina, Tennessee, Texas, Virginia, and B.A.E., U.S. Department of Agriculture. It was supported jointly by State and R.M.A. funds.

The sample was determined by selecting every fourth name from a list of producers provided by the county agents. Included in the sample for the Ruston Area were 26 growers who produced 79 broods of broilers during 1951; 38 producers in the Northwest Area reporting 127 broods during that year; and 42 producers in the Scattered Area who turned out 106 broods. The broods were classified into three different sizes and designated as small, medium, and large. The small size consisted of lots averaging less than 2,500 chicks started, the medium size had 2,500 to 3,499, and the large size included broods of 3,500 or more birds.

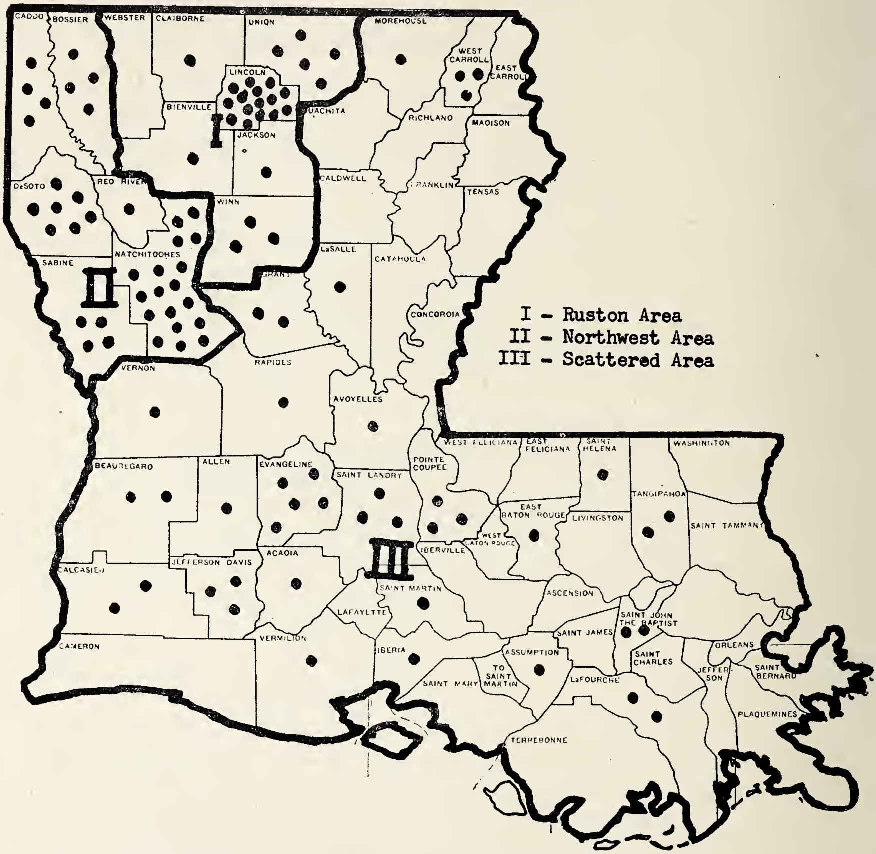


Figure 1. Location of the 106 broiler producers contacted in a state-wide study in Louisiana during 1951.

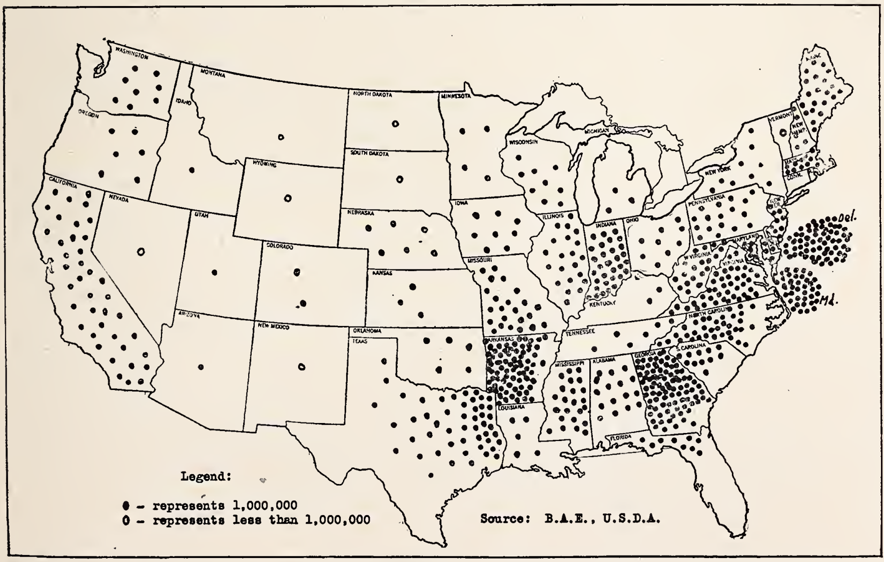
LOCATION OF BROILERS IN UNITED STATES

The location of broiler production is not greatly affected by differences in climate, soil type, or topography, as is clearly indicated by the concentration of broilers in certain sections of the United States (Figure 2). The most important factors determining location are dependable sources of chicks, feed, and outlets for the finished birds, and competition from other enterprises.

The large volume of broiler production along the Atlantic seaboard in Delaware, Maryland, and Virginia may be attributed primarily to good markets provided by the dense population of the areas served, the scarcity of land for other farming enterprises, and the advantage of importing feed over importing live or dressed broilers from the feed producing sections of the Midwest.

The large volume of broilers produced in Arkansas and Georgia may be due to the elimination of less remunerative competitive enterprises. Many families on hill farms where the soil has become depleted for cotton production have turned to broilers. This condition along with the mechanization of cotton and other farm crops has caused many Louisiana farmers also to turn to the broiler enterprise. Being more dependable as a source of cash income than some of the crops, the broiler house promises to become commonplace on the average family farm in the hill sections of Louisiana.

The average prices received for broilers by producers in the United States during 1951 varied from 27.1 cents a pound in Delaware and Maryland, where the supply was relatively large, to 34.0 cents in Arizona, where production was low. In Georgia and Mississippi the average prices were 27.6 cents and 29.3 cents, respectively, as compared with 31.0 cents in Louisiana. The higher price in Louisiana probably was due to the more favorable relationship between local demand and supply. As the volume of production increases to the extent that markets outside the local area have to be tapped, it is likely that profit margins will be narrowed.



Source: B.A.E., U.S.D.A.

Figure 2. Distribution of broiler production in United States, by states, 1951. No attempt was made to establish the exact location of the industry within each state.

BROILER PRODUCERS IN LOUISIANA

Eighty per cent of the broiler growers contacted in Louisiana during 1951 operated their enterprises on a part-time basis while 20 per cent were on a full-time basis, as indicated in Table 1. Part-time producers included farmers, teachers, merchants, fruit growers, and others not fully employed. All of the full-time and about 90 per cent of the part-time operators established their houses at the farm home.

While 20 per cent of the producers who were on a full-time basis received all of their income from broilers, the 80 per cent operating on a part-time basis received an average of only 15 per cent of their cash income from this source and the balance was obtained from the major source of employment.

Over 90 per cent of the broiler houses were operated by family labor, and 84 per cent were managed by persons having had less than one year of experience in producing and marketing broilers.

TABLE 1. Tenure, Income, Source of Labor, and Broiler Growing Experience of 106 Broiler Producers, by Areas, Louisiana, 1951

Status Items	Areas			State (Pct.)
	Ruston (Pct.)	Northwest (Pct.)	Scattered (Pct.)	
Employment:				
Full-time	23	8	31	20
Part-time	77	92	69	80
Income:				
Broilers	15	8	21	15
Other	85	92	79	85
Operator				
Family	92	94	86	91
Hired	8	6	14	9
Experience:				
One year or less	88	94	71	84
More than one year	12	6	29	16

BROILER HOUSES

Probably every person contemplating entering broiler production is confronted with the kind of house to provide, and in many cases funds are insufficient to finance such an undertaking. Also, many growers prefer to "try-out" the business before becoming too heavily involved financially. Some are advised to construct inexpensive houses that will suffice until better ones are needed or can be afforded. Others are told that one should start with a good plant that will be cheaper in the long run and can be used for other purposes, such as for a laying house, in the event of a change in enterprise. As one would expect, the kind of broiler houses constructed varied from one area to another depending on promoted patterns, or lack of patterns, and the method and source of finance.

Type of Construction

To compare types and costs of construction, the broiler houses in Louisiana were divided into four classifications: Type A, Type B, Type C, and Unclassified. Type A houses comprised the ones built of reasonably good material throughout, including concrete foundation strips, aluminum or galvanized tin roofing, commercial type ventilators, and dirt or concrete floors; Type B were constructed of a lower grade of material with composition roofs, make-shift ventilators, and a lower grade of workmanship; the Type C unit usually was some farm building converted to broiler use with little remodeling; and the Unclassified houses were mostly of the battery type with mesh wire floors. Of the 106 producers contacted, 75 per cent had Type A houses; 10 per cent had Type B; 10 per cent, Type C; and 5 per cent, the Unclassified type, which is omitted from Table 2 for lack of comparable data.

Certain items in the design and construction of broiler houses have a direct bearing on the efficiency of operations. Among the most important are roofs, floors, and ventilation. Aluminum roofing was used by a majority of the growers in Louisiana because the houses are kept cooler in the summer months, which stimulates chick growth. Shingles, tin or composition, were employed by others for house covering. Those roofing their houses with aluminum usually applied the same material to the walls. Others used concrete blocks, tin, composition siding, plank, or wire.

A proper floor in a broiler house is conducive to good chick health. A well-drained dirt floor, which has a tendency to stay dry and can be repaired easily with dry material in case of leakage, appeared to be the most practical from the standpoint of service and cost, and was used by nearly all of the Louisiana producers contacted. A study in Delaware during 1942 also reports that dirt floors are most widely used in that state.[1]

The most common types of roof ventilation consisted of round vents or the ridge type extending the entire length of the house. A few growers used forced air or stacks, and others had no special kind of roof ventilators. Side-wall ventilation consisted mainly of flaps or windows. Except during excessively cold weather, many producers kept the side walls of their houses open. The best type of ventilation to use is still controversial among Louisiana broiler producers.

Investment in Houses

The investment in the different types of broiler houses, including equipment, is shown in Table 2. Automatic feeders were observed only in the Type A buildings. The cost of the plants was calculated for the different areas on the basis of 2,400 square feet of floor space per house and by types of houses and feeders.

Automatic feeders were not originally installed in some of the Type A houses but appeared later as a trial method of feeding. They cost about four times as much as the common trough type and hold some promise of replacing the latter. The automatic units were installed in the

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[1] Bausman, R. O., *An Economic Survey of the Broiler Industry in Delaware*, Delaware Agr. Exp. Sta. Bul. No. 242, March 1943, p. 37.

TABLE 2. Initial Cost of Broiler Houses and Equipment, Excluding Family Labor, by Type of House, Type of Feeder, and by Areas,* Louisiana, 1951

Cost Item	Cost of Type A House[1]			Cost of Type A House[2]			Cost of Type B House[2]			Cost of Type C House[2]		
	Area I	Area II	Area III	Area I	Area II	Area III	Area I	Area II	Area III	Area I	Area II	Area III
	Dollars per House											
Building	1536	1992	1392	1440	1728	1800	744	1176	1344	600	0	1056
Equipment												
Feeding	552	1008	504	168	168	144	192	168	144	120	0	120
Watering	96	96	144	72	72	96	48	48	72	72	0	72
Brooding	240	312	216	240	240	264	120	240	216	216	0	240
Total cost	2,424	3,408	2,256	1,920	2,208	2,304	1,104	1,632	1,776	1,008	0	1,488
No. of houses	4	1	3	19	34	19	1	2	7	2	0	9

*Area I is the Ruston Area; Area II comprises the Northwest Area; and Area III is the Scattered

[1] Broiler house with automatic feeder—based on 2,400 sq. ft. of floor space.

[2] Broiler house with hand feeders.

better constructed houses, and were used to lower labor requirements with no better feed utilization being anticipated. It is pointed out by John High that more efficient use of feed may not accompany the automatic feeder.[2]

The total cost of a Type A house with automatic feeders in the Ruston Area was $2,424 for 2,400 square feet of floor space, or $1.01 per square foot. A similar type house in the Scattered Area cost $2,256, or 94 cents per square foot. Type A houses with hand feeders in the Ruston Area cost $1,920, or 80 cents per square foot. The additional cost of installing automatic feeders amounts to roughly $600 per house, or about $400 above the cost of hand feeders. A Type B house in the Ruston Area cost $1,104 without automatic feeders, while in the Scattered Area similar houses were more expensive owing to higher building costs. Type C houses cost about 50 cents a square foot.

Sources of Finance

Broiler production is a type of enterprise that requires relatively heavy initial investment in buildings and equipment. Because of the rapid turnover in production there also is a substantial amount of capita required for production expenses. Chicks and feed, which comprise about 90 per cent of the cost in producing a brood of broilers, must be financed through the growing period. Therefore, long-term financing is needed for capital equipment and short-term for production purposes.

Eighty per cent of the producers in the Ruston Area, 74 per cent in the Northwest Area, and 10 per cent in the Scattered Area received long-term financing from commercial banks supported by F.H.A. Title I funds. Except for the Scattered Area, relatively few provided their own capital or obtained it from sources other than banks.

The principal source of short-term credit was the local feed company Of the 106 growers contacted, 89 per cent in the Ruston Area, 32 per cen in the Northwest Area, and 50 per cent in the Scattered Area depended on this source. Commercial banks extended short-term financing only in the Northwest Area. The dealers supplied the growers with chicks, feed, and medicinal items during the brooding period on an open-account plan. The well established system of credit through feed dealers and banks no doubt was responsible for the rapid development of the broiler business in the Ruston and Northwest Areas of Louisiana.

CHICK SUPPLY

Sources

Some of the producers who were new in the broiler business have had difficulty in developing a steady and reliable source of chick supply. Ove 80 per cent of the growers in the Scattered Area, who were more firml established, obtained their chicks from hatcheries in Louisiana. Ruston producers depended principally on Louisiana and Mississippi hatcheries, while the Northwest producers purchased chicks mainly from Louisiana and Texas hatcheries. A few producers patronized sources in other states, as indicated in Table 3.

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[2] High, John, "Which Feeder is Best for Broilers?" *Broiler Growing,* Watt Publishing Co., November 1952, p. 19.

TABLE 3. Sources of Chicks Started by 106 Louisiana Broiler Producers, by Areas and States of Origin, 1951

Supply State	Areas		
	Ruston (Per cent)	Northwest (Per cent)	Scattered[1] (Per cent)
Louisiana	45.7	41.7	82.2
Mississippi	41.5	6.8	4.2
Texas	1.8	38.5	5.4
Arkansas	5.3	7.7	.0
Others[2]	5.7	5.3	8.2
Total	100.0	100.0	100.0

[1] Many chicks raised in the area were not of the meat type.

[2] Included Georgia, Indiana, Illinois, Kansas, Kentucky, Michigan, Missouri, Oklahoma, Tennessee, and Pennsylvania.

Breeds

Although the New Hampshire was the chick most widely used by Louisiana broiler producers during 1951, the choice appears to have been based mainly on the source of supply. The proportions of the different breeds started in the selected areas during the period of study are shown in Table 4.

In the Ruston Area, about 87 per cent of the chicks started were New Hampshires and the balance were crosses and mixed lots. The Northwest producers reported 58 per cent New Hampshires and a liberal amount of White Rocks and crossbreeds. In the Scattered section, the New Hampshire breed also was predominant. In 1942 Delaware reported Rock-Red crosses as being most popular in that state.[3] Since then, there has been a shift to the New Hampshire. Virginia reports New Hampshires much in the lead.[4]

TABLE 4. Percentage of the Different Breeds of Chicks Started in Three Selected Areas by 106 Broiler Producers in Louisiana During 1951

Breed	Producers by Areas		
	Ruston	Northwest	Scattered
		Per cent	
New Hampshire	86.5	58.0	81.8
White Rock	.6	13.7	4.7
Crosses*	5.4	23.4	6.3
Mixed lots**	7.5	4.9	7.2
Total	100.0	100.0	100.0

*New Hampshire X Barred Rock, Vantress, Indian River, Eureka, and Dark Cornish X New Hampshire.

**New Hampshire, Eureka, Barred Rock, Rhode Island Red, Indian River, Vantress, White Rock, and Dark Cornish.

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[3] *op. cit., An Economic Survey of the Broiler Industry in Delaware*, p. 36.

[4] Plaxico, J. S., *Good Broiler Management Pays,* Va. Ag. Exp. Sta. Bul. 437, June 1950, p. 27.

Diseases

Coccidiosis was the disease most prevalent among one-third of the broiler chicks in Louisiana during 1951, and was followed closely by colds and coryza (Table 5). Studies made in Virginia[5] and Delaware[6] reveal about the same degree of coccidiosis infection in those states as was reported for Louisiana.

Knowing that the egg conveys pullorum to the chick, many producers patronized only hatcheries handling chicks with a rating above "controlled." Ninety per cent of the producers in the Ruston Area used chicks rated either "clean" or "passed." The rest purchased them from hatcheries requiring only "controlled" or no pullorum rating for their hatching egg supply flocks. Of the Northwest producers, 2 per cent purchased "clean" chicks, 50 per cent bought "passed" chicks, and the balance bought chicks of lesser rating.[7]

TABLE 5. Type of Disease and Extent of Occurrence, 114 Broods Reporting, Louisiana, 1951

Type of Disease*	No. of Broods	Per cent of total
Coccidiosis	37	32
Colds and coryza	31	27
Pullorum	22	19
Bronchitis	7	6
Newcastle	7	6
Paralysis	3	3
Nutritional deficiencies	2	2
Others**	5	5
	114	100

*Disease identification based on producers' opinions, often not verified by laboratory diagnosis.

**Other diseases include cholera, gizzard erosion, pneumonia, and epidemic tremor.

Prices

Little variation was noted in the prices paid for chicks by the producers in the different broiler producing areas of Louisiana during 1951, as indicated by Table 6. The average price paid was about 15.5 cents a chick delivered at the broiler house.

RELATED MANAGEMENT PRACTICES

Most of the broiler producers contacted were in the business for the first time and they had the advantage of not having obsolete methods to discard or modify. Being in closely associated groups, they could study and map out their production procedures more effectively than if they were widely scattered. Some of the management practices directly related to the cost of producing broilers included size of brood, livability of

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[5] Plaxico, James S., *Broiler Costs and Returns Related to Management Practices, Rockingham County, Virginia, 1946-47*, Virginia Agr. Exp. Sta. Bulletin 426, April 1949, p. 21.

[6] *op. cit., An Economic Survey of the Broiler Industry in Delaware*, p. 40.

[7] A "clean" rating means no pullorum on two separate tests: "passed," no pullorum on one test; and "controlled" denotes less than 2 per cent reactors to the pullorum test.

TABLE 6. Average Prices Paid for Chicks by 106 Producers, by Size of Broods and by Areas, Louisiana, 1951

Area	Size of brood and prices		
	Small	Medium	Large
	Cents per chick		
Ruston	15.2	15.5	16.0
Northwest	15.8	15.6	15.6
Scattered	15.1	15.4	14.5
Simple average	15.4	15.5	15.4

chicks, length of the production period, weight of birds at sale, feed consumed, and amount of labor employed. Data on these factors for the three areas are shown in Table 7.

Production Factors

The average size of the 312 selected broods started in Louisiana during 1951 varied from 1,292 chicks for the small broods to 4,491 for the large. The average livability for all broods in the state was 93.8 per cent. The number of days the chicks were held in production was closely associated with the weight of the broilers at the time of sale. For example, the medium-sized broods in the Ruston Area were held an average of 64 days, with the birds averaging 2.7 pounds each, while in the Scattered Area they were held 71 days and averaged 2.8 pounds. These variations in age and size of broilers may be attributed to the differences in demand for broilers of different sizes.

Some range in the amount of feed used per pound of broiler was noted. The Ruston Area reported an average feed conversion ratio of 2.9 while the small brood operators in Northwest Louisiana reported a conversion of 3.3 pounds. The average for the state was 3.1.

The amount of labor required to produce a brood of broilers usually decreases as the size of the brood increases, and also may vary with the seasons of the year, the type of labor employed, and the level of mechanization in the broiler house. The family labor expended in producing the different sizes of broods in Louisiana, which comprised over 90 per cent of all labor, varied considerably from one area to another, with an average of 119 hours for the small broods and 186 for the large, and a state average of 140 hours for all broods. The hours per 1,000 broilers produced ranged from 99 to 44 for these broods, and 59 for the state. Research in Virginia reported 167 hours for every 1,000 birds,[8] while studies in Maine reveal the employment of 120 minutes, or two hours a day, per 1,000 broilers.[9]

Floor Space Per Bird

The requirement of floor space per chick is determined mainly by the season of the year, latitude of the producing area, and the age and

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[8] *op. cit., Broiler Cost and Returns* (Va.), p. 28.

[9] Perry, A. L., and Dow, G. F., *Costs and Returns in Broiler Production,* Maine Agr. Exp. Sta. Bulletin 441, December 1945, p. 66.

TABLE 7. Selected Management Data on Broiler Production, 312 Growers, Louisiana, 1951

Item	Unit	Size of brood			Weighted Average
		Small	Medium	Large	
		Ruston Area			
Broods:	No.	14.0	60.0	5.0	26.3
Size of brood started	Birds	1,578.0	3,022.0	4,037.0	2,830.3
Size of brood sold	Birds	1,511.0	2,839.0	3,776.0	2,663.0
Livability	Pct.	95.8	93.9	93.5	94.1
Days birds held	No.	66.0	64.0	67.0	64.5
Weight at sale	Lbs.	2.6	2.7	2.7	2.7
Feed per lb. of broiler	Lbs.	2.9	2.9	3.0	2.9
Family labor per brood	Hours	158.0	147.0	168.0	150.3
Family labor, 1,000 broilers	Hours	104.6	51.8	44.5	57.5
		Northwest Area			
Broods:	No.	27.0	91.0	90.0	42.3
Size of brood started	Birds	1,690.0	3,032.0	3,971.0	2,813.2
Size of brood sold	Birds	1,588.0	2,850.0	3,766.0	2,646.6
Livability	Pct.	94.0	94.0	94.8	94.1
Days birds held	No.	69.0	69.0	68.0	68.9
Weight at sale	Lbs.	2.7	2.7	2.8	2.7
Feed per lb. of broiler	Lbs.	3.3	3.2	3.0	3.2
Family labor per brood	Hours	104.0	145.0	143.0	136.1
Family labor, 1,000 broilers	Hours	65.5	50.9	38.0	51.4
		Scattered Area			
Broods:	No.	76.0	14.0	16.0	35.4
Size of brood started	Birds	1,098.0	3,105.0	4,925.0	1,940.7
Size of brood sold	Birds	1,016.0	2,815.0	4,666.0	1,804.5
Livability	Pct.	92.5	90.7	94.7	93.0
Days birds held	No.	72.0	71.0	70.0	71.6
Weight at sale	Lbs.	2.9	2.8	2.9	2.9
Feed per lb. of broiler	Lbs.	3.2	3.0	3.2	3.2
Family labor per brood	Hours	115.0	206.0	217.0	142.4
Family labor, 1,000 broilers	Hours	113.2	78.2	46.5	78.7
		State			
Broods:	No.	117.0	165.0	30.0	104.0
Size of brood started	Birds	1,292.0	3,035.0	4,491.0	2,521.4
Size of brood sold	Birds	1,207.0	2,844.0	4,248.0	2,365.1
Livability	Pct.	93.4	93.7	94.6	93.8
Days birds held	No.	70.0	67.0	69.0	68.3
Weight at sale	Lbs.	2.8	2.7	2.8	2.7
Feed per lb. of broiler	Lbs.	3.2	3.0	3.1	3.1
Family labor per brood	Hours	119.0	147.0	186.0	140.3
Family labor, 1,000 broilers	Hours	98.6	51.7	43.8	59.3

weight of the broilers at time of marketing. In Louisiana during 1951 slightly less than .8 square foot of floor space was allowed each chick by 23 per cent of the producers in the Ruston Area, 50 per cent in the Northwest Area, and 33 per cent in the Scattered Area. One square foot or more per chick was permitted by 19 per cent, 5 per cent, and 22 per cent, respectively, of the growers in the different areas. The average for the state was about .9 square foot. Fear of respiratory and of other diseases as well as management difficulties from overcrowding may have been the reason for liberal floor spacing. Recent studies in Delaware point out that when the margin between the cost of production and price received is relatively small, the profit from broiler production will be greatest when .75 square foot of floor space per bird is allowed.[10] When the margin is wide, the profit may be greater when less space is permitted each bird.

Hovers and Fuel

Over 95 per cent of the Louisiana broiler producers interviewed used canopy-type brooders during 1951. The balance employed either battery brooders, infrared lights, or stoves. Natural and butane gases provided the source of fuel for a majority of the producers in all areas.

Method and Frequency of Feeding

Automatic feeders which provide constant distribution of feed to the chicks throughout the day were in use by 15 per cent of the Ruston producers and to a lesser extent in the other sections of the state. The percentage of growers feeding chicks less than three times a day and those feeding them three or more times a day was about equal. Most producers started chicks on scratch grain while others used starter mash. Usually during the seventh week of production, broilers were shifted to a "finishing" ration which is lower in protein content.

Litter and Frequency of Change

Wood shavings comprised the bulk of the litter at nearly all of the broiler houses visited. Eleven, 21, and 26 per cent of the producers in the respective areas used bagasse litter, which is a cane by-product. In a few instances sawdust and rice hulls formed the litter. Although between 35 and 55 per cent of the producers changed the litter after each brood of broilers, the trend was toward less frequent change, especially when no evidence of disease was present. Virginia reported shavings as the most commonly used litter,[11] while Delaware growers used sawdust primarily.[12]

Lights in the Broiler House

How and when to use lights at night in the broiler house is a controversial question. A study comprising four trials with different kinds of lighting at the North Louisiana Agricultural Experiment Station contributes some limited but pertinent data.[13] Three kinds of lighting methods were compared: natural, intermittent, and all-night light. Among these systems little difference was noted in chick mortality; feed conversion was slightly in favor of only natural lighting and consequently income margins also were a little higher under that method. Natural lighting yielded the best results only during spring and summer; all-night lighting was the best of the three in fall and winter; and the intermittent lighting gave rather constant but not superior yearly results. Hoffman and Gwin report Heywang as finding no benefit from all-night lighting over lights from midnight to daybreak, and suggested that chicks eat more during the cooler hours of the day or night.[14]

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[10] Smith, R. C., and McDaniel, W. E., *Floor Space Affects Broiler Profits,* Delaware Agr. Exp. Sta. Circular 25, September 1952.

[11] *op. cit., Good Broiler Management Pays,* p. 28.

[12] *op. cit., An Economic Survey of the Broiler Industry in Delaware,* p. 38.

[13] Heath, J.L., Woodward, R.S., and Upp, C.W., *Summary of Broiler Experiments, July 1951 to July 1952,* L.S.U. and North Louisiana Agr. Exp. Sta., Calhoun, Louisiana, 1951-52.

In this study, it was observed that 73 per cent, 84 per cent, and 89 per cent of the producers in the three respective areas used all-night lighting. This practice was not based on any specific research but was assumed to be a good practice. Nearly all of the other producers used intermittent lighting. Only about one-fourth of the broilers produced in Maine in 1944 were under artificial lighting.[15]

Watering Facilities

Three types of waterers were used by Louisiana broiler producers during 1951: automatic waterers such as "drip-type" fountains, semi-automatic which included only running water facilities, and common waterers, or those involving the drawing of water and carrying it to the broiler house. Over 90 per cent of the waterers were of the drip-type. Virginia reports 98 per cent of the broods on its Eastern Shore, and 56 per cent of its Shenandoah Valley lots, were produced in houses with automatic waterers.[16]

MARKETING OF BROILERS

Except for some of the older and more firmly established broiler producers in the Scattered Area, the year 1951 was one of adjustment in marketing as well as in production. The Scattered producers developed their enterprises on the demand of local dealers and groups of various kinds needing dressed birds; e.g., for storage in home refrigerators. As broiler production in the northern part of the state began to exceed the capacity of the local dressing plant, larger and more distant markets had to be sought. With these expanded outlets, additional marketing problems arose. To present the progress being made in marketing broilers in Louisiana and to indicate some of the problems involved, data were obtained on (1) types of outlets used, (2) methods of handling broilers, (3) prices received by producers, (4) market news service available, and (5) some of the major factors affecting marketing of broilers.

Outlets

Four different types of markets were available to most of the producers interviewed; namely, dressing plants, live broiler buyers, dressed markets, and home use. With the exception of the Scattered Area, the small producers sold two-thirds or more of their broilers directly to dressing plants. The balance went principally to live broiler buyers or were sold dressed to stores and individuals (Table 8).

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[14] Hoffman, E., and Gwin, J. M., *Successful Broiler Growing,* Watt Pub. Co., Mount Morris, Ill., 1951, p. 122.

[15] *op. cit., Cost and Returns in Broiler Production,* p. 67.

[16] *op. cit., Good Broiler Management Pays,* p. 29.

The producers with medium-sized operations mostly used the dressing plants. Seventy-eight per cent of the output of the large operators in the Ruston Area, 53 per cent in the Northwest Section, and 42 per cent in the Scattered Area were sold to dressing plants. About 90 per cent of this supply was taken by buyers representing Louisiana dealers who either sold the broilers dressed to individual buyers or to retail stores and restaurants. Most of the remaining 10 per cent was taken by live buyers and resold to large slaughterers or distributors.

TABLE 8. Disposition of Broilers by 106 Producers, by Outlets, Areas, and Size of Broods, Louisiana, 1951

Outlet	Area and size of brood											
	Ruston			Northwest			Scattered			State		
	Sm.	Med.	Lg.	Sm.	Med.	Lg.	Sm.	Med.	Lg.	Sm.	Med.	Lg.
	Per cent of producers											
Dressing plant[1]	64	98	78	77	85	53	28	85	42	48	90	50
Live buyers[2]	9	2	22	11	15	47	25	13	31	19	10	34
Dressed outlets[3]	26	0	0	11	0	0	46	2	27	32	*	16
Home use	1	*	*	1	*	*	1	*	*	1	*	*
Total	100	100	100	100	100	100	100	100	100	100	100	100

[1] Where dealer dressed birds for local retail outlets.
[2] Buyers usually for large dressing and distributing plants.
[3] Usually for strictly local use.
*Less than 1 per cent.

Methods of Handling Broilers

As broilers usually are sold by the pound, they must be weighed during the exchange of ownership. In the Ruston and Northwest Areas where the entire brood was sold at one time, about 90 per cent or more of the birds were weighed in the coop. In the Scattered sections where about 47 per cent of the broods were sold in broken lots, each bird was weighed separately. In a few instances coops and truck were weighed together and the proper deductions made. This method, which appeared to be the most convenient and economical, likely will be most widely used in the future.

At the time of the survey, about 95 per cent of the broilers marketed by the 106 producers contacted were weighed on platform scales and loaded on trucks at the farm. The sales transaction was terminated at the broiler house. Most of the buyers assisted the producers in weighing and loading but none of the buyers attempted to grade the birds. It may be expected, however, that as broilers become relatively more plentiful and the margin between cost of production and the price received decreases, more grading will be done.

Prices Received for Broilers

The average prices received for broilers by Louisiana producers on the basis of outlet, area, and size of brood during 1951 are presented in Table 9. Although the prices were accurately recorded, the wide variations between prices from one area to another and from one size of brood to another indicate difficulty of comparison. On the whole, the prices were relatively high in all areas because of the relatively short supply and unusually good demand.

Much of the output of the small units was supplied to the local trade at prices above the average of other areas where the volume was larger and the broilers had to be sold in more competitive markets. Producers in the Scattered Area operated under diverse production conditions and although the prices received for their birds were high, often the cost of production also was high. No doubt the prices most representative of market values were the ones received for the medium-sized broods in the Ruston and Northwest Areas.

TABLE 9. Prices Received for Live Broilers, by Outlets, Areas, and Size of Broods, Louisiana, 1951

Outlet	Area and size of brood											
	Ruston			Northwest			Scattered			State		
	Sm.	Med.	Lg.	Sm.	Med.	Lg.	Sm.	Med.	Lg.	Sm.	Med.	Lg.
	Cents per pound of broiler											
Dressing plant	30	29	28	29	29	28	31	30	29	30	29	28
Live buyers[1]	29	27	24	31	27	26	38	33	35	36	28	30
Other[2]	35	*	*	38	*	*	36	40	39	36	40	39
Average (simple)	31	28	26	33	28	27	35	34	34	34	32	32

*No sales.

[1] In the Scattered Area this included consumer purchasing.

[2] Dressed birds sold to stores, cafes, individuals, etc. Calculated in live weight equivalents.

Market News

Two-thirds of the producers in the Ruston Area and one-third in the Northwest section received market news from the Louisiana Market Commission. A few of the more isolated producers obtained price information from this source and from the radio. Except for the Ruston producers, about one-half of the growers had no regular market news service.

RETURNS TO PRODUCERS

Most of the labor utilized in the production of broilers in Louisiana during 1951 was supplied by the family. This kind of labor varied widely in efficiency and was difficult to calculate on an hourly or other comparable basis. Because of this difficulty, family labor was omitted from the cost structure and made a recipient of the residue in the balancing of receipts and costs, as shown in Table 10.

Receipts

About 96 per cent of the receipts to broiler producers consisted of proceeds from sale of broilers and about 4 per cent from credits for such items as birds consumed by the family, reclaimed feed, receipts from sale of manure or its estimated value, salvaged feed bags, and adjustments for chick losses. The gross receipts per pound of broiler during 1951 ranged from 28 cents for the large broods in the Ruston Area to 36 cents for the small broods in the Scattered Area. The weighted averages for the state by different sizes of broods were 34.0, 29.8, and 31.7 cents, respectively.

Costs

Feed and chicks together comprised about 90 per cent of the cost of producing a broiler, excluding family labor. Other items such as fixed charges, utilities, and medicines accounted for the balance. The average cost for the state was about 68 cents. The cost of producing a pound of broiler varied from 23.4 cents for the medium-sized brood in the Ruston Area to 26.8 cents for the small brood in the Scattered Area.

Feed amounted to 68 per cent of the cost of producing broilers in Louisiana excluding family labor (Figure 3). Virginia records the same percentage for feed.[17] The feed cost per pound of broiler in Louisiana varied from 15.7 cents for the medium-sized brood in the Ruston Area to 18.3 cents for the small brood in the Northwest Area. The state average was about 17 cents per pound of broiler.

The cost of chicks was about 25 per cent of the total cost of producing broilers for market, and averaged about 6 cents a pound of bird. The cost on a brood basis varied little among the producers using broiler type chicks exclusively. The other items of cost, although important, were relatively small in the aggregate and showed only minor variations from one area or one size of brood to another.

Net Returns

Net returns per pound of broiler marketed ranged from 3.7 cents for the large broods in the Ruston Area to 9.2 cents for the small broods in the Scattered Area. Probably the most representative figure for the state was that for the medium-sized brood, which for the state averaged 5 cents. For this brood the net return per bird of 2.72 pounds was 13.6 cents. This size brood netted family labor an average of $386.78, and an hourly return to labor of $2.63.

FACTORS AFFECTING NET RETURNS

Feed

Although feed is the major factor of cost in producing broilers, in Louisiana during 1951 it varied widely in price from one community and from one brand to another with little knowledge of variations in quality. In this study, the relationship between price and feeding value of the different rations was not ascertained, but from observation it was felt that price-quality relations should be more carefully considered by the broiler producers.

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[17] *op. cit., Good Broiler Management Pays,* p. 16.

TABLE 10. Returns to 312 Producers for Live Broilers, by Areas and by Sizes of Broods, Louisiana, 1951

Returns and Cost Items	Area and size of brood											
	Ruston			Northwest			Scattered			State		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
	Cents per pound of broiler											
Receipts:												
Broiler sales	31.1	28.8	27.1	29.9	28.5	27.1	34.8	30.5	33.4	32.8	28.8	30.8
Credits[1]	1.1	.8	.9	1.2	1.1	1.1	1.2	1.0	.7	1.2	1.0	.9
Total	32.2	29.6	28.0	31.1	29.6	28.2	36.0	31.5	34.1	34.0	29.8	31.7
Costs:												
Feed	16.2	15.7	16.6	18.3	17.8	16.6	18.0	16.7	17.7	17.9	16.9	17.3
Chicks	6.2	6.2	6.3	6.2	6.1	5.8	5.7	6.0	5.3	5.9	6.1	5.6
Fixed charges[2]	.8	.9	1.0	1.0	.9	.8	1.3	1.3	.9	1.1	.9	.9
Utilities	.5	.3	.2	.3	.3	.2	.4	.3	.2	.4	.3	.2
Medicines	.1	.2	.1	.3	.3	.2	.4	.3	.2	.3	.3	.2
Other[3]	.3	.1	.1	.3	.2	.3	1.0	.5	.7	.7	.3	.4
Total	24.1	23.4	24.3	26.4	25.6	23.9	26.8	25.1	25.0	26.3	24.8	24.6
Net Returns per lb.	8.1	6.2	3.7	4.7	4.0	4.3	9.2	6.4	9.1	7.7	5.0	7.1
	Cents per bird											
Returns per bird	20.9	16.5	10.1	12.9	11.0	12.1	26.6	18.1	26.2	21.6	13.6	20.2
	Dollars											
Net returns:												
Per brood sold	315.80	468.44	381.38	204.85	313.50	455.69	270.26	509.52	1222.49	260.71	386.78	858.10
Per hour labor	2.02	3.20	2.29	2.04	2.27	3.15	2.41	2.45	5.69	2.27	2.63	4.58

[1] Includes birds eaten, reclaimed feed, manure, feed bags, and hatchery adjustments for chick losses.

[2] As interest on invested capital and depreciation on house and equipment.

[3] Includes hired labor, litter, hauling, phone calls, light bulbs, disinfectants, etc.

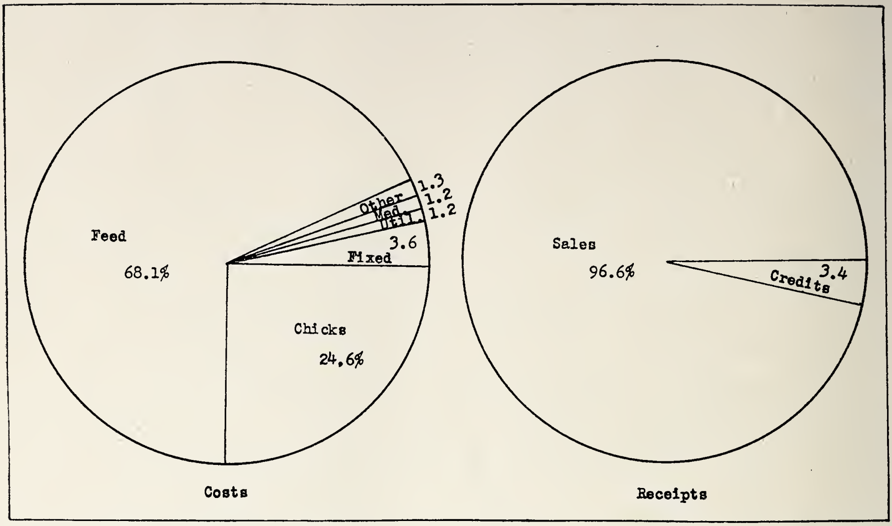

Figure 3. Illustration of costs and returns involved in producing the medium-sized brood of broilers in Louisiana during 1951.

Feed Prices

The price paid for feed by broiler growers varied from $4.75 a hundred pounds for a certain brand in one community to $6.25 for a different brand in another, and the average price paid for all feeds used for the medium-sized broods was $5.62. Based on a 13.6-cent net return per bird weighing 2.72 pounds, a feed conversion of 3.0, and a gross market return of 30 cents a pound for broilers, the effect of variation in the price of feed on net returns to family labor is shown in Figure 4. For example, if all of the feeds had had a 3.0 conversion ratio and had been purchased at $4.75, the average net return per bird to the producer for his labor and management would have been 20.8 cents instead of 13.6 cents; and conversely, if all the feed had cost $6.25 and had a 3.0 conversion ratio, the net returns would have been 8.6 cents a bird. From the charted data other examples of the effect of feed prices on net returns easily may be calculated.

Feed Conversion

Feed conversion is another item in feed use that affects considerably the net returns to broiler producers. Feeds vary in power to produce broiler meat as well as they do in price. Based on the average price of all cost and receipt items in this study, the effect of differences in feed conversion ratios is shown in Figure 5. The charted ratios, which represent the major part of the actual spread recorded in the survey, range from 2.6 to 3.4.

If the average feed conversion ratio had been 2.6 instead of 3.0, the net returns per broiler to family labor would have been 19.9 cents instead of 13.6 cents. On the other hand, if the average ratio had been 3.4, the net returns to the producer would have been 6.0 cents lower, or 7.6 cents instead of 13.6 cents.

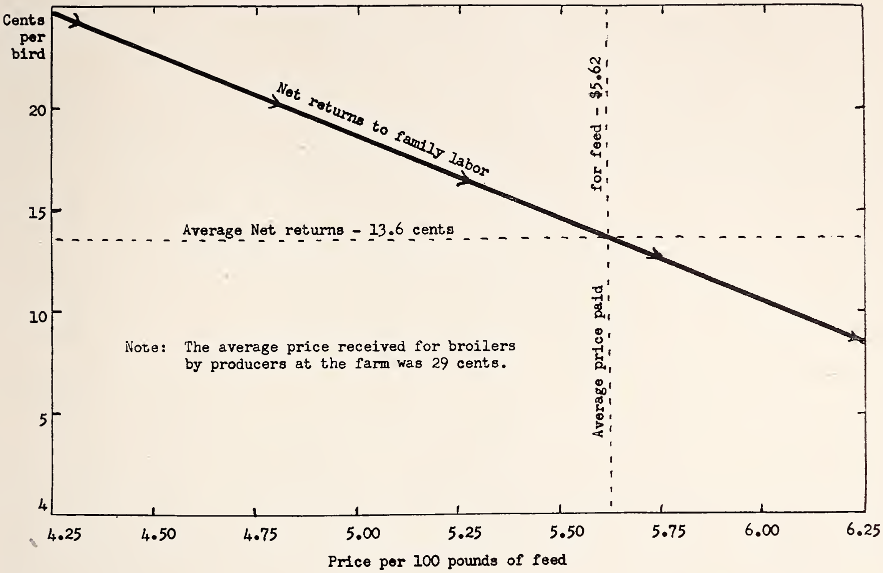

Figure 4. Effect of variations in feed prices on the net returns to family labor, based on broiler operations in Louisiana during 1951.

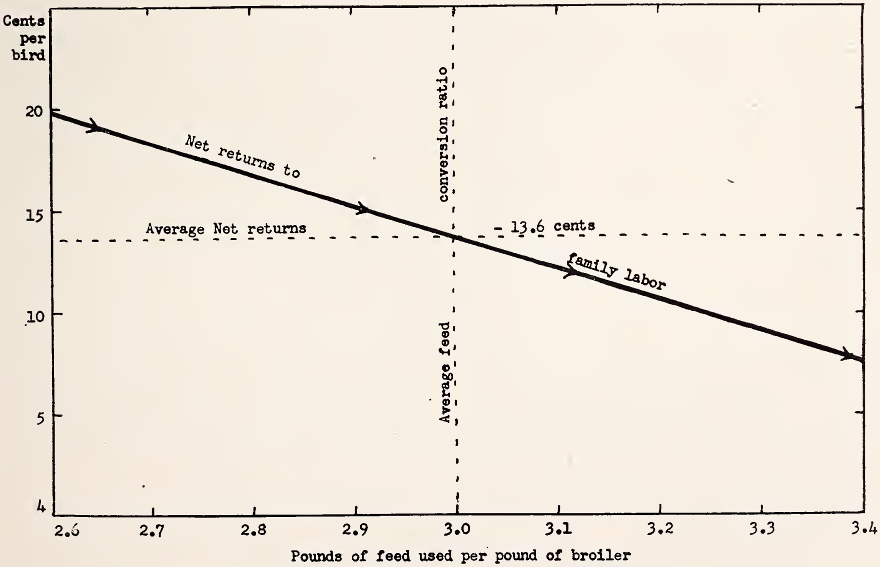

Figure 5. Effect of variations in feed conversion ratios on net returns to family labor, based on broiler operations in Louisiana during 1951.

Feed Efficiency

One may hear feed salesmen say: "My feed is higher priced but it is better and cheaper to use," or, "My feed costs less, is just as good as the higher priced feed, and therefore more economical to use." It is generally known that different brands of feed vary in price, but the extent to which they vary in quality is not so well known. Actually, the most profitable feed to use is the one that will yield a certain size broiler at the lowest cost. An attempt has been made to present data (in part interpolated) that will explain price-quality relationships in feeds (Table 11).

TABLE 11. Application of Feed Cost-Feed Quality Relationship to Economy in Producing Broilers, Louisiana, 1951

Average feed cost per bird* (cents)			Feed cost per 100 lbs. (dollars)		Amount of feed (lbs.)			Feed conversion ratio (in lbs. feed)**			Average size of broiler (lbs.)
45.9	would	at	6.50	buy	7.06	which	with	2.60	would	produce	2.72
45.9	"	"	6.25	"	7.34	"	"	2.70	"	"	2.72
45.9	"	"	6.00	"	7.65	"	"	2.81	"	"	2.72
45.9	"	"	5.75	"	7.98	"	"	2.93	"	"	2.72
45.9	"	"	5.50	"	8.35	"	"	3.07	"	"	2.72
45.9	"	"	5.25	"	8.74	"	"	3.21	"	"	2.72
45.9	"	"	5.00	"	9.18	"	"	3.38	"	"	2.72
45.9	"	"	4.75	"	9.66	"	"	3.55	"	"	2.72

*The average-size bird weighing 2.72 pounds and converting feed at 3.0 consumed 8.16 pounds of feed which, at the average price of 5.62 cents a pound, amounted to a cost of 45.9 cents.

**These necessary feed conversions are not intended in any way to indicate the "actual" feed conversion ratios of different priced feeds.

The average cost for feed to produce a 2.72-pound broiler using feed at $5.62 a hundred pounds was 45.9 cents. How much feed could be purchased with the 45.9 cents at different prices, and what would the feed conversion ratio have to be to produce the 2.72-pound bird? Referring to the table, 7.65 pounds of $6.00 feed having a 2.81 conversion ratio would be equal to 9.18 pounds of $5.00 feed with a 3.38 ratio, or vice versa. One important discrepancy in these comparisons is the limited capacity of chicks to consume the amount of the bulkier feed needed for satisfactory growth. This limited consumption factor would restrict somewhat the economy in using low converting feeds. Another factor would be the small added cost in handling the larger quantity of the lower quality feed during the growing period. The most economical feed to use would be the one having the most favorable price-quality-consumption relationship. If not otherwise available, the producer might obtain some information that would be helpful to him through feed analyses or feeding experiments.

Price of Chicks

Chick purchases constitute the second largest item of expense in producing broilers, or about one-fourth of the total cost. The prices paid by growers during 1951 varied from 11 cents to 19 cents a chick. The average cost was about 15.5 cents. Although, in general, price was an index to quality, sometimes producers had to pay high prices for birds of inferior quality. On the other hand, occasionally during the year some of the most reliable dealers had surpluses and sold chicks of superior quality at greatly reduced prices. Being new in the business, some of the producers contacted were unable to procure quality chicks or bargain for them in terms of price. Probably in the future better values can be realized.

The effect of varying chick costs on the net returns to family labor is shown in Figure 6. Had all of the chicks been purchased at an average of 11.0 cents instead of 15.5 cents, the returns would have been 18.3 cents a broiler instead of 13.6 cents. At the price of 19.0 cents the margin would have been lowered to 10.2 cents. Every producer should remember that one penny saved on the price of a chick would mean a saving of $30 in the cost of a medium-sized brood of 3,000 birds.

Chick Mortality

As the bulk of the chick deaths in Louisiana during 1951 occurred during the first three weeks of the production period when little feed had been consumed, the losses from this cause were the unrecovered costs comprising the purchase price of the chicks and the proportionate overhead expenses involved. Of course, the older the chicks are at death the greater the amount in feed losses.

Besides observing the methods used to prevent chick losses from communicable diseases in the broiler house, care should be given to the procurement of chicks that are of correct breeding and are free from

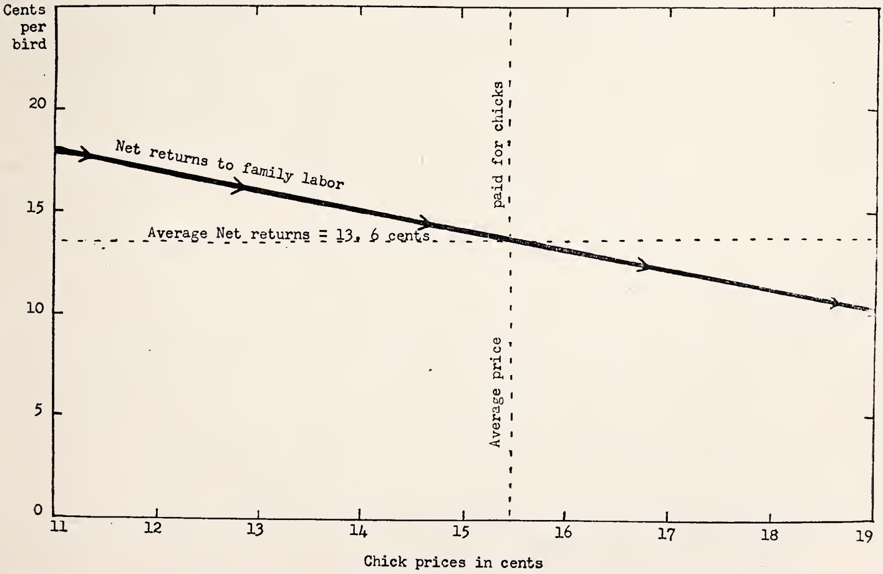

Figure 6. Effect of variations in chick prices on net returns to family labor, based on broiler operations in Louisiana during 1951.

pullorum. The average death loss for the medium-sized broods of chicks in Louisiana during 1951 was 6.1 per cent, or about $30 for every 3,000 birds started. The seriousness of the losses depends principally on the age of the chick at death. Indiana reported the following regarding mortality:

"Death losses in the two-year period (1946-48) averaged 11 per cent of the chicks ordered. People who regularly lose a large percentage of their chicks cannot hope to make profits. Labor returns per hour drop sharply as mortality increases. Sick birds require more feed and more attention than well ones. They take longer to reach the same average weights."[18]

Delaware reported that as mortality increased, costs continued to increase until the 28 lots reporting an average loss of 31.2 birds per 100 had a cost of production of 39.4 cents per pound and made negative net gains.[19] Average mortality in Maine was 11.5 per cent.[20]

Price for Broilers

In the markets, sellers attempt to obtain the highest price possible for their product while the buyer tries to get the same product at a reduced price. Because this is true, broiler producers should exert all

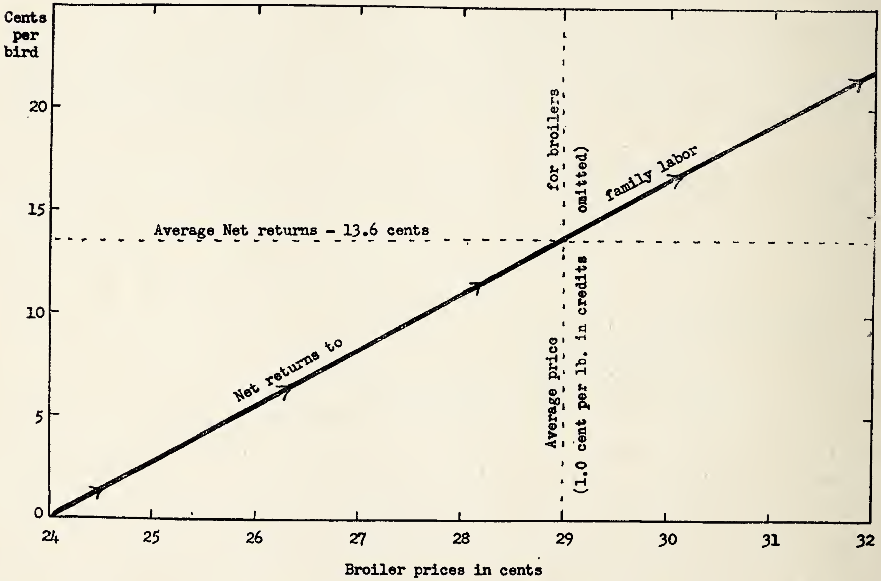

Figure 7. Effect of variations in broiler prices on net returns to family labor, based on broiler operations in Louisiana during 1951.

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[18] Johnson, H. A., Gordeuk, A., and Robertson, L. S., *Profitable Broiler Production,* Ind. Ag. Exp. Sta. Bul. 539, March 1950, p. 18.

[19] Bausman, R. O., *Influence of Management Practices on Cost of Producing Broilers,* Del. Ag. Exp. Sta. Bul. 270, Sept. 1947, p. 14.

[20] *op. cit., Cost and Returns* (Maine), p. 66.

the effort they can to better their own financial interest. One cent a pound more for the broilers from the medium-sized brood during 1951 would have netted the producer $81.60 more for a lot of 3,000 birds. One cent a pound less would have reduced net returns the same amount. The effect of variations in price on net returns to family labor is shown in Figure 7.

The average price received for broilers by producers marketing medium-sized lots was 28.8 cents a pound live weight, where, at this price, the net return from a 2.72-pound bird was 13.6 cents. At 32 cents a pound, other factors remaining constant, the return would have been 22.3 cents a bird; or, conversely, at 24 cents, plus the credits of different kinds, the net returns to labor would have been down to zero, or no returns to family labor and management.

If at the average 1951 price for broilers the cost of producing them had been reduced 10 per cent, the net returns to management and family labor from a brood of 3,000 broilers would have been $194 more than it was, or $612 instead of $408. The gain on a 12-month operation comprising four broods would have been $776, or a total income for the year of $2,448 instead of $1,632.

SUMMARY AND CONCLUSIONS

1. Broiler production is relatively new in Louisiana with over 90 per cent of it having been established since 1946. The growth has occurred principally in the hill-farming sections of the state where broilers are replacing cotton as a cash enterprise.
2. Eighty per cent of the broiler growers during 1951 operated on a part-time basis. They comprised farmers, teachers, merchants, and many persons not already fully employed. Over 90 per cent of the broiler houses were operated by family labor and were managed by persons having had less than one year of experience in the broiler business.
3. The type of broiler house construction varied widely from houses constructed of good material, including aluminum roofing and siding, to the old farm building converted to broiler use with little remodeling. However, 75 per cent were of the best type. Some of the better houses were equipped with automatic watering systems while others had the common hand waterers. Nearly all of the houses had well-drained dirt floors.
4. The average cost of the better broiler houses equipped with hand waterers was about 90 cents a square foot of floor space, or about $2,100 for a house of 3,000 capacity. Over 80 per cent of the producers in the northern part of the state and about 10 per cent in the southern section financed their house construction through com-

mercial banks supported by F.H.A. Title I funds. Their production operations were supported mainly by open-account credit at the local feed store.

5. About one-half of the chicks utilized in different areas were from Louisiana. Other states contributing to the chick supply were Mississippi, Texas, and Arkansas.
6. The breed of chicks most widely used by Louisiana broiler producers was the New Hampshire, and next in order of preference was the White Rock. Coccidiosis, colds, pullorum, and other diseases were prevalent in the Louisiana broods. In general, precautions were used to combat these maladies.
7. The size of broods varied from 1,292 to 4,491 chicks started. The average livability of the chicks was 93.7 per cent, days held were about 64, and the weight of the bird at date of sale averaged from 2.7 to 2.8 pounds. The feed conversion ratio for the state was about 3.1. The family labor expended per brood averaged 140 hours.
8. The amount of floor space permitted each chick during the production period varied between producers, with no definite amount of space being settled upon. The tendency was to compromise on about .75 of a square foot. Over 95 per cent of the hovers used were of the canopy type. Wood shavings comprised the bulk of the litter. In some areas, bagasse, a sugar cane by-product, was used. The tendency was not to change litter after the removal of each brood of broilers. Over 75 per cent of the producers employed all-night lighting and used "drip-type" waterers.
9. Ninety per cent of the broilers produced in the medium-sized houses were sold to operators of dressing plants. The balance went to live buyers, dressed outlets, and stores. Where the entire brood was sold at one time, the broilers were handled principally by weighing the transporting truck before and after loading and establishing the weight of the birds. The average seasonal price paid to producers for broilers varied widely during 1951. The average price was about 32 cents a pound.
10. Receipts for the medium-sized brood amounted to an average of 30 cents a pound of bird. The cost of producing a pound of broiler, excluding family labor, was about 25 cents. Of this amount, feed was 68 per cent and chicks, 25 per cent. The average net return was 13.6 cents per bird, or $386.78 per brood of 3,000 birds and $2.63 per hour of family labor.
11. The most important cost item affecting net returns to family labor and management was the price of feed. For example, at the average price of $5.62, the net returns were 13.6 cents a broiler. For each 10 per cent reduction in this price of feed, the returns would have been increased about 4.4 cents a bird. Variations in feed conversion ratio, the price paid for chicks, and prices received for broilers are

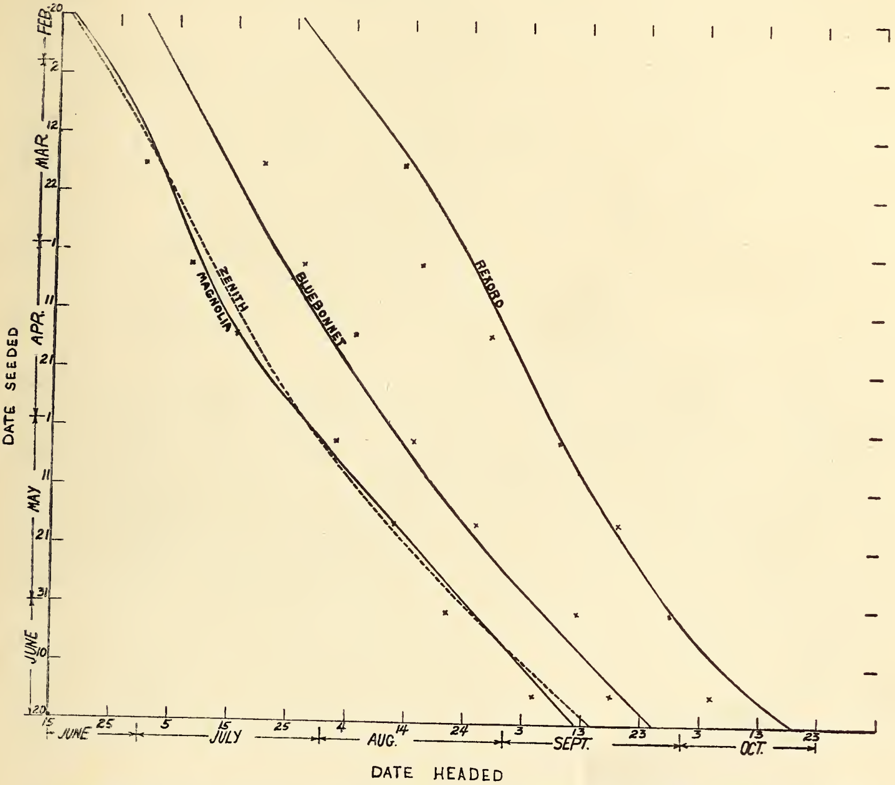
also important factors affecting the net returns to broiler producers.

12. Because of the relatively high prices paid for broilers, producers in Louisiana during 1951 netted a reasonable return for their labor and investment. However, it should be pointed out that if the prices of broilers decline with increasing production, many producers will be forced out of business unless feed costs can be reduced proportionately.

Louisiana Bulletin No. 476 June 1953

Growing Period Of Leading Rice Varieties When Sown on Different Dates

By Nelson E. Jodon



Heading date of four rice varieties in Louisiana following different dates of seeding at the Rice Experiment Station, Crowley, La. The X marks are from data on Early Prolific, Fortuna, and Rexoro published in Louisiana Bulletin No. 384.

Louisiana State University
and
Agricultural and Mechanical College
Agricultural Experiment Station
W. G. Taggart, *Director*

Growing Period of Leading Rice Varieties When Sown On Different Dates[1]

NELSON E. JODON[2]

The length of the growing period of the leading rice varieties in Louisiana when grown in experiments to determine the best time of seeding is reported in this bulletin. These results should serve as a useful guide for planning seasonal operations.

The curves on the cover page show the average first heading dates for seedings extending from February 20 to June 20 for Zenith, Magnolia, Bluebonnet, and Rexoro, the four leading rice varieties grown in Louisiana in 1952. The dates of heading shown are based upon a total of 26 periodic seedings of Magnolia and 27 each of the three other varieties from 1941 through 1951. Most of the seedings were in April, the month in which the greater part of the crop is sown, but seedings of all four varieties were made on the earliest and latest indicated dates. Each curve approximates the average date of heading for the entire range of seeding dates as determined by results from the actual dates on which the experimental seedings were made.

Table 1 shows the typical date of heading (appearance of first panicles) and ripening for given dates of seeding. The heading dates are taken from points on the curves shown on the cover. An average figure for the number of days from heading to full ripening was added to the computed heading dates to arrive at the approximate date for harvesting. Thirty-seven days were added for Zenith, 39 for Magnolia, 38 for Bluebonnet, and 40 days for Rexoro. These averages were obtained from the same seedings as were the dates of heading. The number of days from heading to maturity averaged 39.5 for the 29 varieties reported on in Louisiana Bulletin No. 436.[3] The length of the period from the beginning of the flowering stage (represented by the date of first heading) to full maturity may vary ten days or more from different seedings. Irregular heading and cool weather prolong the period.

The length of the growing period or total number of days from seeding until the rice is fully mature and ready for harvest is shortened steadily, up to a certain point, as the seeding date is delayed.

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[1] Cooperative investigations conducted at the Rice Experiment Station, Crowley, Louisiana, by the Louisiana Agricultural Experiment Station, and the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture.

[2] Associate Agronomist.

The dates of midpoint between the emergence of the seedlings and first heading are included in the table to serve as a guide for timing fertilizer topdressings. In calculating these dates it was assumed that rice will require 14 days to emerge if seeded in February or March, 10 days if seeded in April or the first part of May, and 7 days if seeded in latter May or June.

Previous experiments on date of seeding have been reported in Louisiana Bulletin No. 384,[4] but Rexoro is the only variety in those experiments that is still being grown to any extent. The reaction of Early Prolific to seeding date is very similar to that of Zenith and Magnolia. Bluebonnet is a few days earlier than was Fortuna but it reacts to seeding date in a similar manner. The data for the Early Prolific, Fortuna, and Rexoro varieties from the earlier report are indicated by crosses near the curves on the cover page. The data from Bulletin No. 384 are from seedings on about the 1st and 15th of each month from March 15 to June 15.

[3] Jodon, Nelson E., and de la Houssaye, D.A. Rice Varieties for Louisiana. La. Agr. Expt. Sta. Bul. 436. February 1949.

[4] Jenkins, J. Mitchell, and Jones, Jenkin W. Results of Experiments with Rice in Louisiana. La. Agr. Expt. Sta. Bul. 384. August 1944.

Factors Influencing Length of Growing Period

Day length is the main factor influencing the length of the growing period in rice. The days shorten as the season advances following the summer solstice (the longest day of the year, June 22), and the onset of head formation is induced when the daylight period is sufficiently short. Late varieties do not head until the days are shorter than is the case with earlier varieties. From Table 1 it is clear that usually the later the rice is seeded, the fewer the total number of days from seeding to maturity. There is a fairly regular decrease in the length of the growing period, except that the early varieties tend to reach a minimum. When rice is sown extremely early, or is held over through the winter, flowering may be induced by the short days in early spring. Varieties that are relatively "sensitive" to day-length reaction tend to mature more uniformly than do the less sensitive ones.[5] Experiments show that, after sufficient vegetative development has been reached, most varieties will begin formation of the panicle-bud almost at once if allowed only 10 hours of daylight.[6] There would be little need for Table 1 if it were not for the short-day flowering reaction that occurs in rice. Without this reaction each variety

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[5] Adair, C. Roy. Effect of Time of Seeding on Yield, Milling Quality, and Other Characters in Rice. Jour. Amer. Soc. Agron. 32: 697-706. Sept. 1940.

[6] Beachell, H.M. Effect of Photoperiod on Rice Varieties Grown in the Field. Jour. Agr. Res. 66: 325-340. May 1, 1943.

Table 1. Calculated growing period for four rice varieties sown on different dates from February 20 to June 20 at the Rice Experiment Station, Crowley, La.

Date of Seeding	ZENITH				MAGNOLIA				BLUEBONNET				REXORO			
	Mid-point[1]	Date Headed	Date Ripe	Growing Period (days)	Mid-point[1]	Date Headed	Date Ripe	Growing Period (days)	Mid-point[1]	Date Headed	Date Ripe	Growing Period (days)	Mid-point[1]	Date Headed	Date Ripe	Growing Period (days)
2/20	4/27	6/17	7/24	154	4/26	6/17	7/26	156	5/3	6/30	8/7	168	5/16	7/26	9/4	196
2/22	4/28	6/17	7/24	152	4/27	6/18	7/27	155	5/4	7/1	8/8	167	5/17	7/27	9/5	195
2/24	4/29	6/18	7/25	151	4/29	6/19	7/28	154	5/6	7/2	8/9	166	5/19	7/29	9/7	194
2/26	5/1	6/19	7/26	150	4/31	6/21	7/30	154	5/7	7/3	8/10	165	5/21	7/30	9/8	193
2/28	5/3	6/21	7/28	150	5/2	6/22	7/31	153	5/9	7/4	8/11	164	5/23	8/1	9/10	193
3/1	5/3	6/21	7/28	149	5/3	6/23	8/1	153	5/10	7/5	8/12	164	5/24	8/2	9/11	193
3/2	5/5	6/23	7/30	150	5/4	6/23	8/1	153	5/10	7/5	8/12	163	5/25	8/3	9/12	193
3/4	5/6	6/24	7/31	149	5/6	6/25	8/3	152	5/12	7/6	8/13	162	5/26	8/4	9/13	192
3/6	5/8	6/25	8/1	148	5/8	6/26	8/4	151	5/13	7/7	8/14	161	5/28	8/6	9/15	192
3/8	5/9	6/26	8/2	147	5/9	6/27	8/5	150	5/15	7/8	8/15	160	5/30	8/7	9/16	191
3/10	5/11	6/28	8/4	147	5/11	6/28	8/6	149	5/17	7/10	8/17	160	5/31	8/8	9/17	190
3/12	5/13	6/29	8/5	146	5/12	6/29	8/7	148	5/18	7/11	8/18	159	6/2	8/10	9/19	190
3/14	5/15	7/1	8/7	146	5/14	6/30	8/8	147	5/20	7/12	8/19	158	6/4	8/12	9/21	190
3/16	5/16	7/2	8/8	145	5/15	7/1	8/9	146	5/21	7/13	8/20	157	6/6	8/13	9/22	189
3/18	5/18	7/3	8/9	144	5/17	7/2	8/10	145	5/23	7/14	8/21	156	6/8	8/15	9/24	189
3/20	5/19	7/4	8/10	143	5/18	7/3	8/11	144	5/24	7/15	8/22	155	6/9	8/16	9/25	188
3/22	5/21	7/5	8/11	142	5/20	7/4	8/12	143	5/26	7/16	8/23	154	6/11	8/17	9/26	187
3/24	5/22	7/6	8/12	141	5/21	7/5	8/13	142	5/27	7/17	8/24	153	6/13	8/19	9/28	187
3/26	5/23	7/7	8/13	140	5/22	7/6	8/14	141	5/29	7/18	8/25	152	6/14	8/20	9/29	187
3/28	5/26	7/8	8/14	139	5/24	7/6	8/14	139	5/30	7/19	8/26	151	6/16	8/21	9/30	186
3/30	5/26	7/8	8/14	137	5/25	7/7	8/15	138	6/1	7/20	8/27	150	6/17	8/22	10/1	185
4/1	5/26	7/9	8/15	136	5/25	7/8	8/16	137	6/1	7/22	8/29	150	6/17	8/23	10/2	184
4/2	5/27	7/10	8/16	136	5/26	7/9	8/17	137	6/1	7/22	8/29	149	6/18	8/24	10/3	184
4/4	5/28	7/11	8/17	135	5/27	7/10	8/18	136	6/3	7/23	8/30	148	6/19	8/25	10/4	183
4/6	5/30	7/12	8/18	134	5/28	7/10	8/18	134	6/5	7/25	9/1	148	6/21	8/26	10/5	182
4/8	6/1	7/14	8/20	134	5/30	7/11	8/19	133	6/6	7/26	9/2	147	6/22	8/27	10/6	181
4/10	6/2	7/15	8/21	133	6/1	7/13	8/21	133	6/8	7/27	9/3	146	6/24	8/28	10/7	180
4/12	6/4	7/16	8/22	132	6/2	7/14	8/22	132	6/10	7/29	9/5	146	6/25	8/29	10/8	179
4/14	6/5	7/17	8/23	131	6/4	7/15	8/23	131	6/11	7/30	9/6	145	6/27	8/30	10/9	178
4/16	6/7	7/18	8/24	130	6/5	7/16	8/24	130	6/13	7/31	9/7	144	6/28	8/31	10/10	177
4/18	6/8	7/19	8/25	129	6/7	7/17	8/25	129	6/15	8/2	9/9	144	6/30	9/1	10/11	176

(Continued)

Table 1. (Continued)

Date of Seeding	ZENITH				MAGNOLIA				BLUEBONNET				REXORO			
	Mid-point[1]	Date Headed	Date Ripe	Growing Period (days)	Mid-point[1]	Date Headed	Date Ripe	Growing Period (days)	Mid-point[1]	Date Headed	Date Ripe	Growing Period (days)	Mid-point[1]	Date Headed	Date Ripe	Growing Period (days)
4/20	6/10	7/20	8/26	128	6/9	7/19	8/27	129	6/16	8/3	9/10	143	7/1	9/2	10/12	175
4/22	6/12	7/22	8/28	128	6/10	7/20	8/28	128	6/18	8/4	9/11	142	7/2	9/3	10/13	174
4/24	6/13	7/23	8/29	127	6/12	7/22	8/30	128	6/20	8/6	9/13	142	7/4	9/4	10/14	173
4/26	6/15	7/25	8/31	127	6/14	7/24	9/1	128	6/21	8/7	9/14	141	7/5	9/5	10/15	172
4/28	6/17	7/26	9/1	126	6/16	7/25	9/2	127	6/23	8/9	9/16	141	7/7	9/6	10/16	171
4/30	6/18	7/27	9/2	125	6/18	7/27	9/4	127	6/25	8/10	9/17	140	7/8	9/7	10/17	170
5/1	6/19	7/28	9/3	125	6/19	7/28	9/5	127	6/26	8/11	9/18	140	7/9	9/8	10/18	170
5/2	6/20	7/29	9/4	125	6/20	7/29	9/6	127	6/27	8/11	9/18	139	7/10	9/9	10/19	170
5/4	6/22	7/30	9/5	124	6/22	7/31	9/8	127	6/28	8/13	9/20	139	7/12	9/10	10/20	169
5/6	6/24	8/1	9/7	124	6/23	8/1	9/9	126	6/30	8/15	9/22	139	7/13	9/11	10/21	168
5/8	6/25	8/3	9/9	124	6/24	8/3	9/11	126	7/2	8/16	9/23	138	7/15	9/12	10/22	167
5/10	6/27	8/4	9/10	123	6/26	8/5	9/13	126	7/4	8/18	9/25	138	7/16	9/13	10/23	166
5/12	6/29	8/6	9/12	123	6/28	8/7	9/15	126	7/5	8/19	9/26	137	7/18	9/14	10/24	165
5/14	7/1	8/8	9/14	123	6/30	8/9	9/17	126	7/7	8/21	9/28	137	7/20	9/16	10/26	165
5/16	7/1	8/9	9/15	122	7/1	8/10	9/18	125	7/8	8/23	9/30	137	7/20	9/17	10/27	164
5/18	7/3	8/11	9/17	122	7/3	8/12	9/20	125	7/9	8/24	10/1	136	7/22	9/18	10/28	163
5/20	7/5	8/13	9/19	122	7/5	8/14	9/22	125	7/11	8/26	10/3	136	7/23	9/19	10/29	162
5/22	7/7	8/15	9/21	122	7/7	8/16	9/24	125	7/13	8/28	10/5	136	7/25	9/21	10/31	162
5/24	7/9	8/17	9/23	122	7/9	8/18	9/26	125	7/15	8/29	10/6	135	7/27	9/23	11/2	162
5/26	7/11	8/19	9/25	122	7/11	8/20	9/28	125	7/17	8/31	10/8	135	7/29	9/24	11/3	161
5/28	7/13	8/21	9/27	122	7/13	8/22	9/30	125	7/19	9/2	10/10	135	7/31	9/25	11/4	160
5/30	7/15	8/23	9/29	122	7/15	8/24	10/2	125	7/21	9/4	10/12	135	8/2	9/27	11/6	160
6/1	7/17	8/25	10/1	122	7/16	8/24	10/2	124	7/23	9/6	10/14	135	8/3	9/28	11/7	159
6/2	7/18	8/26	10/2	122	7/17	8/26	10/4	124	7/24	9/7	10/15	135	8/4	9/29	11/8	159
6/4	7/20	8/28	10/4	122	7/19	8/28	10/6	124	7/26	9/9	10/17	135	8/6	10/1	11/10	159
6/6	7/22	8/30	10/6	122	7/21	8/30	10/8	124	7/28	9/11	10/19	135	8/8	10/3	11/12	159
6/8	7/24	9/1	10/8	122	7/23	9/1	10/10	124	7/30	9/13	10/21	135	8/9	10/4	11/13	158
6/10	7/26	9/3	10/10	122	7/25	9/3	10/12	124	8/1	9/15	10/23	135	8/11	10/6	11/15	158
6/12	7/28	9/5	10/12	122	7/27	9/4	10/13	123	8/3	9/17	10/25	135	8/13	10/8	11/17	158
6/14	7/30	9/8	10/15	123	7/29	9/6	10/15	123	8/5	9/19	10/27	135	8/16	10/11	11/20	159
6/16	8/1	9/10	10/17	123	7/31	9/8	10/17	123	8/7	9/21	10/29	135	8/18	10/13	11/22	159
6/18	8/3	9/12	10/19	123	8/2	9/10	10/19	123	8/9	9/23	10/31	135	8/20	10/16	11/25	160
6/20	8/5	9/14	10/21	123	8/4	9/12	10/21	123	8/10	9/23	11/1	134	8/23	10/19	11/28	161

[1] Midpoint date between emergence and heading.

would have a growth period of nearly constant length, regardless of seeding date. Other factors influence the length of the growth period. If germination is retarded by dry soil or cold weather the crop will ripen later than if it had germinated promptly. Cool weather while the grains are filling retards maturity. A field that heads unevenly will not be ready for harvest so soon as one that heads uniformly. Fertilizer use can make several days difference in the length of the growth period. Unpublished results from fertilizer experiments at the Rice Experiment Station show that phosphorus and nitrogen applied together hasten maturity somewhat, but very heavy applications of nitrogen create an unbalanced nutrition that delays maturity.

Using Table I

The grower who sows rice at different dates in the spring or has more than one variety can use Table I to time his seedings so that each field will be ready for harvest at convenient intervals. Planned seeding may permit the crop to be harvested at a time when the drier will be able to give unhurried service instead of during the peak of the season.

Available drying facilities are now sufficient to handle the whole crop if too great a volume of rice is not harvested at any one time. But there is a trend toward increased acreages of early varieties and most of this, if sown in April as usual, will be harvested during the latter part of August. Perfect harvest weather saved the situation in 1952, but frequent showers ordinarily can be expected in August. Growers can avoid this period of congestion at the driers by postponing the seeding of early varieties until mid-May.

The information on time of maturity also can be used by the grower to determine how long he can postpone seeding while working out red rice. He can assure himself that he is seeding early enough to have the crop mature before danger from frost. One of the earliest damaging frosts occurred on October 8, 1952. Freezing temperatures seldom occur before October 20, and often not until well into November. Probably any field ready for harvest by October 20 would be far enough advanced to escape appreciable injury from any frost coming earlier.

Because of the frost hazard it is advisable to seed Rexoro not later than May 15. Bluebonnet may be safely seeded up to June 15, and Zenith and Magnolia may be seeded as late as July 1.

The date of heading shown in Table 1 can be used as a guide for the safe application of 2,4-D for weed control. This chemical should be applied at least three to four weeks before heading because the developing rice panicle is very sensitive to 2,4-D.

Date-of-heading is being used as a guide in experiments in progress on control of the rice stinkbug. Correct timing of sprays should give a maximum reduction in amount of "pecky rice," but no definite recommendations can be made at the present time.

The "midpoint" date in Table I is the approximate last date for effective topdressing with fertilizers. It applies particularly when part of the fertilizer is applied at time of seeding.[7] Earlier application is desirable when the appearance of the plants indicates a need for fertilizer.

Effect of Date of Seeding on Yield

Table 2 shows the average yields of the leading varieties in small-plot date-of-seeding tests from 1950 to 1952. Except in 1950, these tests were on land that had not been in rice for several years and no fertilizer was applied for that reason. These results show that yields are lower from June seedings than from earlier seedings. The data reported in Bulletin No. 384 also indicate lower yields from June seeding. Profitable, though not maximum, yields are attainable from late seeding, especially if the land is properly fertilized.

Table 2. Yields of four rice varieties in date-of-seeding tests at Crowley, Louisiana, 1950 to 1952, inclusive.

Variety	ACRE-YIELD (Barrels) WHEN SEEDED:							
	3/25/52	4/5/51	5/3/51	5/9/52	6/11/52	6/13/50	6/20/51	Average
Zenith	20.6	23.0	20.2	23.1	16.1	16.4	15.7	19.3
Magnolia	21.8	21.9	21.6	19.5	14.5	15.7	16.6	18.8
Bluebonnet	20.2	19.7	21.0	19.5	14.6	17.0	14.3	18.0
Rexoro	20.6	11.2	15.5	16.1	**	8.1*	**	15.7
	20.8	19.0	19.6	19.6	15.1	16.4	15.5	18.0

*Frost injury, omitted from average.
**Failure due to frost

Rexoro seeded in June failed because of frosts in 1951 and 1952, and was injured somewhat in 1950. The highest yield from this variety in these tests was from the earliest seeding. The data in Bulletin 384 show that Rexoro yielded fully as well as Fortuna and Blue Rose when sown from March 15 to May 15.

Zenith, Magnolia, and Bluebonnet appear to be equally productive from seedings at any given seeding time up to June 15. Production reports compiled by the Rice Millers Association show very small differences in average yields of the leading varieties now grown in Louisiana.

Early vs. Late Seeding

The greater part of the rice crop in Louisiana is seeded in April or early May, but some growers prefer to sow at least part of their crop as early as possible. Probably there is a greater danger of loss of stand from early seeding, but very good results usually are obtained. Seed treatments are advisable to help insure a stand from early seeding. The greatest incentive for extremely early seeding probably is that of quick cash returns, but better control of grass and red rice is an important consideration also. There is some indication that less "white tip" occurs in early-seeded fields. Early varieties mature before the period of greatest danger from windstorms, while late varieties have sufficient time to make their maximum production.

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[7] This is included at the suggestion of Rufus K. Walker, Superintendent of the Rice Experiment Station. The proper time to topdress is the most popular question regarding rice fertilization.

Some rice is seeded late in June and even in July. Rice seeded in hot weather germinates rapidly and can be watered promptly for weed control. Late seeding is resorted to where fields are heavily infested with red rice. The fields may be disked several times before seeding, bringing dormant red rice seeds to the surface where they will germinate and can be destroyed by further cultivation. The final cultivation before seeding should be a very shallow disking that will bring up only a minimum amount of red rice to permit it to germinate with the crop. The Zenith variety is commonly used for extremely late seedings.

Since a crop reaches maturity in a shorter time when it is sown late, it may then require somewhat less water. Rice does not grow so tall from late seeding.[8] Milling quality of rice maturing in cooler weather is usually better than that maturing in hot weather, except for actual damage by low temperatures. October, the month in which most of the late-seeded rice matures, is usually dry and pleasant for harvesting.

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[8] Adair, *op. cit.*

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RICE CROP RECORDS

Year	Dates Of:—				
	Seeding	Top-dressing	2,4-D Application	First Heading	Harvest

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